Editorial

SOME time ago, the PMG was asked to approve the issue of two new forms of amateur licence—the Technician for well-qualified persons and the Novice probationary licence.

Together they extend amateur activity at both ends of the scale, bringing it into line with the vastly widened scope of the radio art. Both licences have been available and popular in America for some time.

There are two firm arguments in favor of these new licences. The first is that together they increase the usefulness of the amateur licence, bringing the greatest benefit to the largest number. The second is that in encouraging more citizens to obtain experience in radio transmission, the nation will add to its pool of partially and fully trained men at no cost to itself.

The PMG has now announced that it will grant the Technician licence, but not the Novice licence. The reason given was that the Defence Department thinks Technicians will be of some value, but Novices not enough to offset unspecified administrative difficulties.

This is a most disturbing pronouncement to any thinking amateur for many reasons. It should make us seriously suspect our present community standing.

The Novice licence was intended to provide a training ground for prospective amateurs. Every holder would be a prospective "ham". Must we therefore assume that, although the Defence Department considers amateurs and technicians of value, it doesn't favor encouraging their growth on this basis?

Prewar amateurs who know how they rated in 1939 will be particularly interested to hear that the Defence Department doesn't favor encouraging them in 1953!

In any case, what has happened to amateur radio when the PMG relies on advice from the Defence Department when deciding whether or not it will grant Novice licences? Even assuming that the Defence Department isn't interested, does that mean that the PMG doesn't want to encourage amateurs either? Where are the weighty reasons amateurs have a right to expect if something they consider vital—and it is vital—cannot be done?

Although their rights have been flagrantly violated by other services, amateurs are given frequency assignments by international agreement on the assumption that local administrations will allow them to be used. There is to my mind an obligation for our Government to grant amateurs every possible facility, and the least possible restriction, with due respect to the rights of others.

I believe the Novice case to be reasonable, desirable, and practicable. It is a shock to realise that we must bargain for it. I sincerely hope the decision of the PMG will be reconsidered and reversed.

John Moyle

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RADIO AND HOBBIES IN AUSTRALIA

A NATIONAL MAGAZINE OF RADIO, HOBBIES AND POPULAR SCIENCE

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Presumably taken from a helicopter, this picture shows the top of Britain's newest TV aerial at Wenvoe in South Wales. 750ft. high and sited 400ft above sea level, the aerial is fed from the world's most powerful TV transmitter. Signals are radiated from the array at the top, but the slots lower down may carry a future VHF service.

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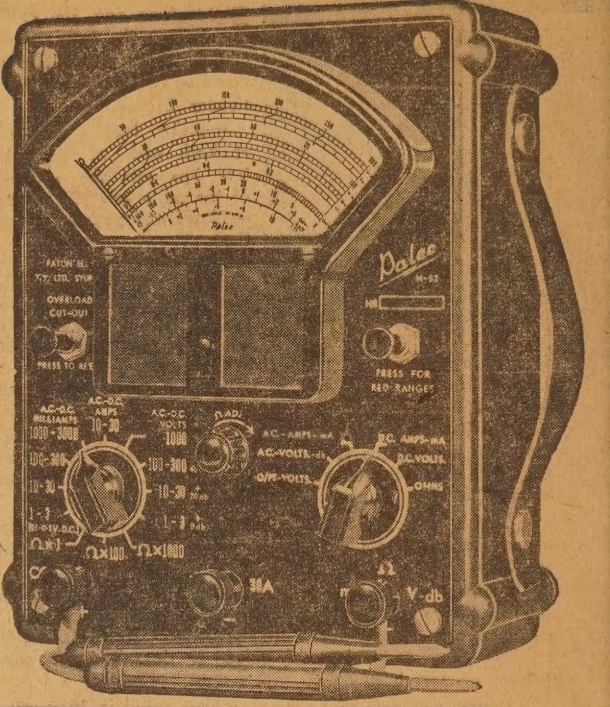

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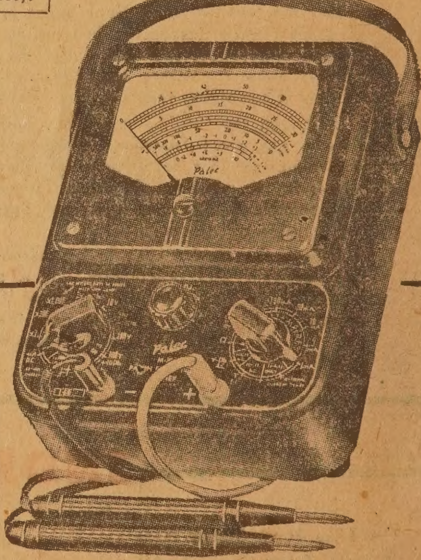

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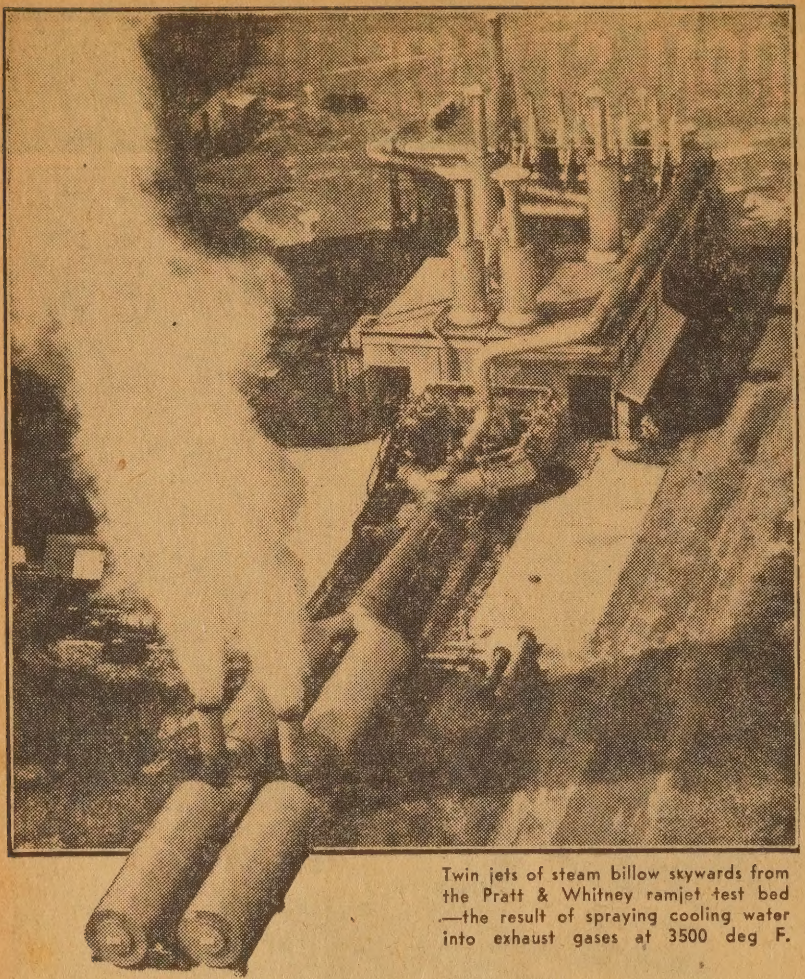
THE MIKE BOOM STANDS HERE....

THE presentation of a television show demands careful planning and the frequent use of model sets, on which the full-scale sets are later patterned. James Bould, set designer for the BBC, checks over the camera and mike positions for shots inside and outside a "house". Scenes like this will become familiar in Australia when television is introduced.



Twin jets of steam billow skywards from the Pratt & Whitney ramjet test bed —the result of spraying cooling water into exhaust gases at 3500 deg F.

RAMJETS PROVE THEIR METAL

While the factories are turning out thousands of conventional jet aircraft, the eyes of designers and tacticians alike are turning toward yet another era when the screaming turbines will give place to the simple yet powerful ramjet. Here is a story of research by the Pratt and Whitney Company, makers of the famous "Wasp" series of piston motors.

THE ramjet is the least developed member of the jet family, but it holds promise of becoming one of the most powerful.

Turbojets have powered a rapidly increasing number of aeroplanes since the first types were flown during World War II, but ramjets have yet to be used extensively.

Test planes, and a few commercial aircraft, are flying daily with turboprop engines, the propeller version of the turbojet.

Other relatives of the jet family made their marks several years ago. Popping pulsejet engines in 1944 carried the German's first V-weapons over the English Channel.

The V-2's that arched through the stratosphere from the Continent to England were driven by rocket engines, and since 1947 rocket-powered aircraft have repeatedly hurtled man far beyond the speed of sound.

William P. Gwinn, general manager of Pratt and Whitney Aircraft division of United Aircraft, has stated that the engine-building company will develop and build ramjet engines for high-speed guided missiles for the Navy.

The ramjet will round out the company's program of building all types of air-burning engines, including turbojet, turboprop and piston powerplants.

FURTHER EXPANSION

He revealed that more than six years of work on ramjets has already been done at East Hartford by the research department of United Aircraft Corporation and that Pratt and Whitney Aircraft has the fruits of this research.

Pratt and Whitney Aircraft's Andrew Wilgoos Turbine Laboratory, the most complete company-owned jet engine test facility of its kind, will be expanded within a few months to take over the ramjet projects begun in the research department's ramjet division.

The ramjet engine has been described as a "stovepipe with a fire in it." In equally simplified terms, it would be fair to describe the big Wasp Major engine as "28 pistons turning a propeller shaft."

Although the ramjet may be thought of as essentially a tube open at both ends, the front end of the tube must be highly "educated" to swallow the correct amount of air and deliver it to the combustion zone, and the aft end must be able to withstand the high temperatures and stresses developed there.

In addition, accurate fuel-metering devices are required to feed the proper amounts of fuel into the swift flow of compressed air, baffles of one kind or another are needed to direct the fuel-air mixture properly into the combustion chamber, and an ignition system is needed to light the fire.

As an aircraft powerplant, the ramjet can be installed in ways similar to turbojet practice — attached in "pods" to the fuselage or wings, buried in the fuselage, or submerged in the wings.

Although their use is not restricted, ramjets are usually associated with guided missiles. In the slang of the aeronautical engineer these pilotless aircraft have been called "birds" since shortly after World War II, and this name has also been applied to the flight-test vehicles used to test ramjet powerplants.

In 1946 United Aircraft undertook a program of small-scale ramjet-burner research on a test stand.

In March, 1947, the company's research department began design and development studies for the ramj research laboratory.

Ground was broken for the laboratory in October, 1948, and the facilit began operating on April 6, 1950.

The stand, a joint project of th Navy's Bureau of Aeronautics ar United Aircraft, has provided bas information concerning the fundamental problems of the ramjet. Pa of the work has been experiment research sponsored by the Bureau Aeronautics, and part of the resear has been concerned with the guid missile program under Project Mete of the Navy's Bureau of Ordnance.

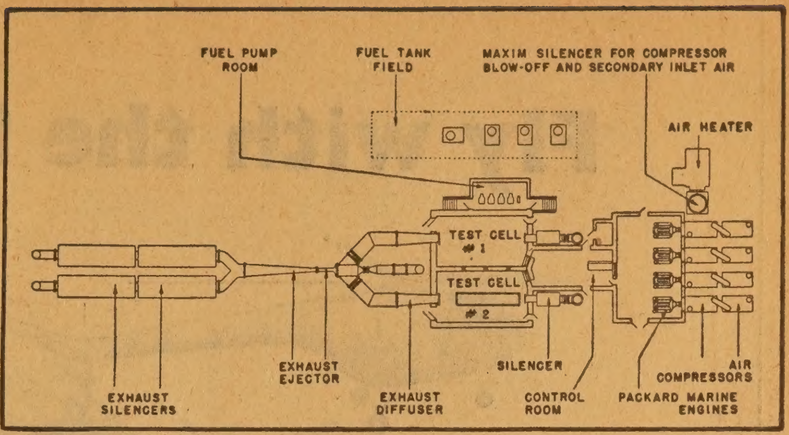
Pulsejet and gas turbine burne also may be tested on the stand.

One of the early problems encou tered in ramjet testing was the e tremely high noise level generated the burning of such large fuel qua tities in relatively small engines.

During the two years that the ramjet test stand has been operated at Reutschler Airport, the noise and power of the experimental engines has been effectively muffled within the walls and silencers of the laboratory.

So well has the test stand been silenced that it can scarcely be heard at a distance of 100 yards. It is considered one of the most quiet of its kind in the country.

This diagram shows the layout of the ramjet test set-up, as pictured on the opposite page. The equipment has been used for testing all types of jet engines and will continue to figure largely in the US Navy Bureau's Project Meteor.



From outside the laboratory the est clue to the fact that experimental ngines are in operation are twin lumes of steam shooting skyward rom the upturned ends of the ex-aust silencers.

The steam, which aids in smothering the exhaust noises, results when vater is sprayed into gases at temeratures about 3500 degrees F. which our from the ramjet exhaust nozzle. he noise is further deadened by tons f sand packed into the double-walled xhaust and intake pipes of the tand's two test cells.

The intake pipes are insulated beause the engineers found that test oises run upstream into the incoming ir flow as well as downstream hrough the exhausts.

The silencing features and the verall design of the test stand were rojects in themselves. The lack of ngineering information on acoustics s applied to muffling the roar of a amjet under test made it necessary do the design and development ork on an actual test stand.

For this purpose a small-scale rototype stand was constructed nd tests were made using miniature ngines before the final design of e test stand was completed.

Despite the ascendancy of the turojet engine, the ramjet remains teresting because it possesses feaires not found in the turbojet.

Unlike the turbojet, which has a mpressor run by a turbine, the mjet has no highly stressed spining blades to pack the air into its rners. Once it has been brought to a high speed the ramjet comesses its own air supply simply by amming" forward.

UILDS UP PRESSURE

As "the bird" shoots ahead, the r flowing into the open front end the ramjet builds up pressure in e combustion chamber.

Studies indicate that, at speeds ster than two or three times that sound, the ramjet has a lower ecific fuel consumption than the rbojet, and that at speeds above at of sound the ramjet can be pected to develop more thrust per und of weight than the turbojet.

For example, when flying at 50,000 t at Mach 2 (twice the speed of ind) a ramjet will weigh from e third to one quarter as much as turbojet designed for the same opulsive power. As a result of s improved fuel consumption and ostantial weight-saving, the ramjet a very attractive power plant for ersonic applications.

Some aeronautical engineers believe the ramjet is a "natural" to power the helicopter. The ramjet engines would be attached to the whirling tips of the rotor blades. However, since the helicopter rotor blades now travel at speeds below that of sound, this application requires the development of a low speed or subsonic ramjet.

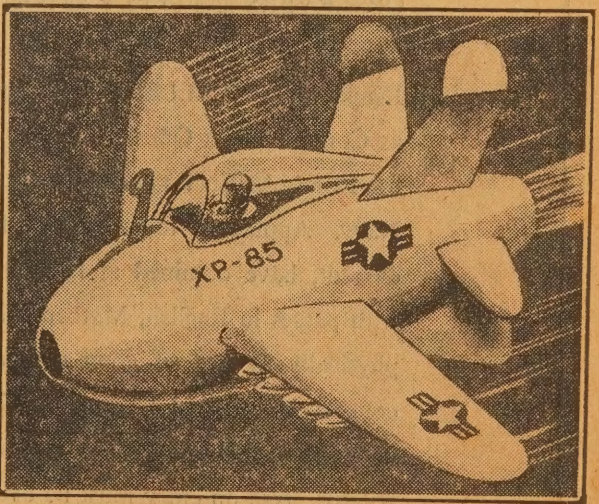
These possibilities make the ramjet an intriguing engine. Where speeds greater than a thousand miles an hour are considered for "birds", or for aeroplanes, the ramjet has definite advantages.

The ramjet has a drawback; solely a high-speed engine, it cannot start by itself. It must be launched by rockets or carried aloft by aircraft powered by other engine types. Once sufficient speed is reached the ramjet takes hold on its own.

The most frequently heard sound from the test stand is that of the four Packard marine gasoline engines which supply compressed air to the burners on test. These four large engines operate the blowers which ram compressed air into the ramjets at a rate of thousands of cubic feet a minute.

☆

A typical developmental "parasite" fighter, intended to be carried in the under-belly of the B-36 bomber. Should the bomber be attacked on a mission, the fighter is released, returning to the bomber before its fuel supply is exhausted. Since it is launched at high speed, a parasite fighter of this type is ideally suited to the use of a ramjet engine.



Gasoline can be supplied to a test engine at the rate of more than 50 gallons a minute.

The compressed air can be heated to 400 degrees F. to duplicate the conditions of high-altitude, supersonic-speed flight of the experimental "birds."

An air ejector line, which runs over the top of the laboratory and connects with the exhaust diffusers, can be used to create low pressures and simulate high altitudes.

The test stand can simulate low-altitude flight by supplying compressed air directly to the test burner or can simulate high-altitude flight with the low pressure available when the exhaust ejector is used.

The compressor drive engines can be operated completely automatically or each engine can be brought into play individually. The compressors are run up to desired speeds by the operator, and the test controller with head set and microphone at the observatory window takes over for finer adjustments of the pressure system by hand.

MOVES FREELY

An automatic safety system prevents the starting of the ramjet or shuts it off if the test is not working properly.

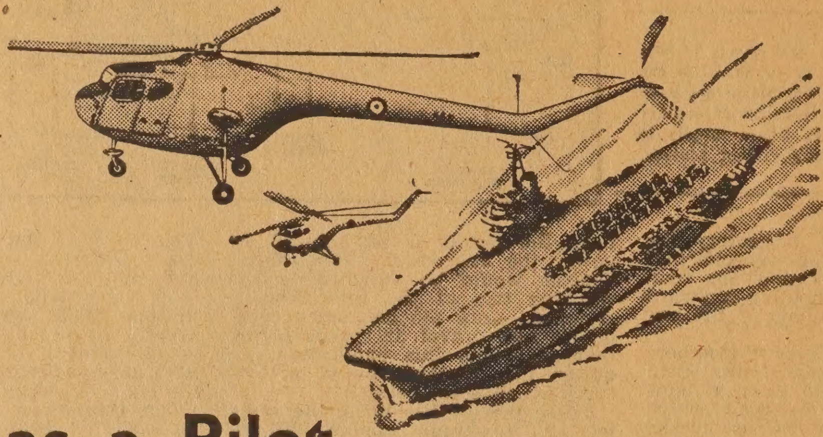
The fuel supply is automatically shut off if there is no spark to ignite the gasoline. This prevents the ramjet and the exahust piping from becoming choked with explosive raw gasoline and fumes.

As an extra fire safety feature, the test cells can be filled instantaneously with heavy fog from eight water nozzles.

Ventilators clear the air of each test cell every 20sec to prevent accumulation of fumes. The ventilating air enters and leaves the test cells through large silencers which pre-

(Continued on Page 101)

Fly with the Navy



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GOOD SEASON OR A DROUGHT?

UNTIL they master the problem, the vagaries of the weather will remain one of the unsolved riddles of the atmosphere, as puzzling and complex as any confronting the scientific world today.

Australia is vitally interested in seasonal forecasting today, as it makes a nation-wide bid to lift food production to help feed a hungry world and, at the same time, increase its overseas trade balances.

The benefit to primary production will be enormous when and if reliable seasonal forecasts are issued. If they can be issued only with a reasonable degree of accuracy, they will still be of considerable value.

Nations would be better prepared for the famines that follow droughts in the densely populated countries of Asia and the meteorologists' advice would govern the size and type of crop planted.

Since Biblical days man has tried desperately to predict next season's weather. Many have had some success, more through good luck than applied science, most have failed. Now, after centuries, meteorologists in many countries, including Australia, believe the greatly increased knowledge being gained about the higher layers of the atmosphere may eventually lead to successful seasonal forecasting.

The Australian wheat farmer could plant his crop with greater assurance if he knew the approximate time of germination and harvest; Northern Australian cattle owners would have reliable information on the vital monsoonal rains and the thousands of southern Australian graziers would plan their shearing on the advice of the late summer and early autumn predictions.

Farmers in the marginal wheat and cattle area would cease gambling on the weather, which has governed their wealth and poverty for generations.

ACTION NEEDED

In recent years several world scientific conferences* have expressed alarm at the world food shortage, but they have done little to relieve it. British Commonwealth scientists, meeting in Melbourne early last year, urged UN to make a world-wide drive to meet the food shortage.

Until some far-reaching system of substantially increasing food production can be evolved, millions must face starvation each year. A system of seasonal forecasting, reliable and accurate, would make a tremendous contribution to the world food shortage.

With the growth of meteorology in the last half-century, research officers have tried to evolve a practical method of seasonal forecasting based on sound, established scientific principles.

Long series of rainfall observations were first examined for evidence of regular recurrence of dry and wet seasons.

At one stage, many investigators were believed to have discovered such "cycles." New ones are still being reported. Other cycles have been postulated on astronomical grounds.

Unfortunately, the early enthusiasm which greeted the investigator as he studied this system was short-lived. Most of these cycles appear to break down in an unpredictable manner. Today they are regarded of little or no practical value for the future.

Only one group of cycles, suspected to be linked to events on the sun, such as sun spots and chromospheric eruptions, basis of ionospheric predictions, continues to be studied.

by Roth Jones

Former director of the Indian Meteorological Service (Sir Gilbert Walker) sponsored another system early in the century for forecasting the vital monsoonal rains.

He based his correlation theory for seasonal forecasting on reports from other parts of the world. For many years it was well received and his papers were published in leading world scientific journals.

20 years later, the former meteorological research officer in Melbourne (Mr. E. T. Quayle) found that large August-September rainfalls in northern Victoria were often preceded by unusually low barometric readings at Darwin during June and July.

This system, too, unfortunately, has not stood up to the test of time. General opinion today is that these correlations, which once looked so significant, represented coincidences rather than real connections.

In the last 40 years several other theories, which, at first, seemed hopeful, were studied, but were found of little practical value.

The Scripps Oceanographic Institute at La Jolla, the colorful little community outside San Diego, in Southern California, propounded that the surface temperatures of the oceans could be used to forecast the next season's rainfall.

Famous Norwegian explorer Fritjof Nansan, whose polar exploits 50 years ago thrilled the world, suggested the water temperature in the northern arctic circle was an important factor contributing to the next season's weather in the northern hemisphere.

The phenomenal development of aviation in the last two decades and the need for information on the higher atmosphere has introduced new, promising theories into seasonal forecasting, which are already achieving partial success.

EFFECT OF WINDS

First proposed by Franz Baur, a German meteorologist, this theory was subsequently developed by the US Weather Bureau and several American universities including the Massachusetts Institute of Technology.

Briefly, the method used is to estimate the wind distribution at 10,000 feet for the coming month and to interpret this into actual weather for that month.

Forecasts are being issued fortnightly on this basis with various degrees of accuracy by the Extended

(Continued on Page 17)

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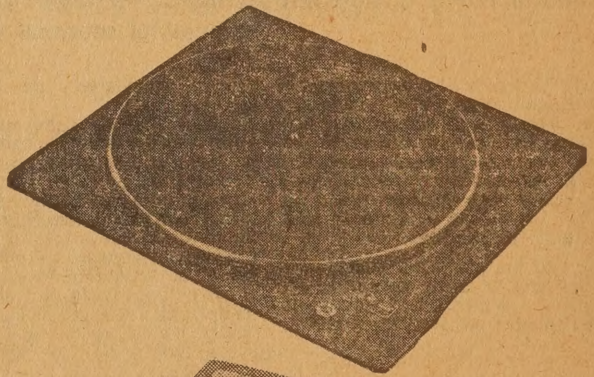

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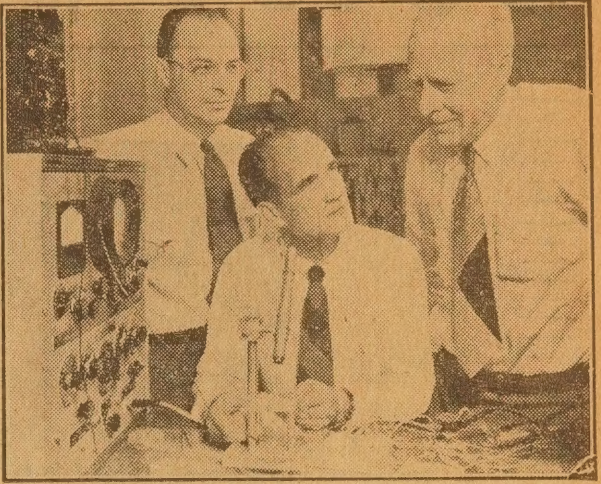
THE CHEMISTRY OF GERMANIUM

Following the success of the wartime "crystal diode", germanium has come into prominence as the basis of the modern transistor or "crystal triode". But what is germanium . . . metal or non-metal? Where does it come from and how is it purified? This article, extracted from the US Engineering Newsletter, supplies the answer to these questions.



The team from the Bell Telephone Laboratories which pioneered development of the germanium transistor. In the centre is Dr. William Shockley, who directed the research program.

NOT until the fundamentals of solid-state physics were being developed, was much attention paid to germanium. When developing crystal rectifiers about 10 years ago, the National Defence Research Council wanted a material with semiconducting properties that could be made of high purity and handled easily. Pure germanium proved to be one of the most adaptable.

At the time, germanium was mostly a scientific curiosity, and sold for 10dol. per gram. Since 1935, germanium has been produced as a by-product of zinc smelting.

The production of germanium dioxide on a pilot-plant scale started in 1941. A year later, the pilot plant was producing germanium dioxide of 99.9 pc purity, which was still not pure enough for rectifier purposes. Since then, improved techniques have increased the purity; and now the total impurities are only a few parts per million.

GERMANIUM SOURCES

Germanium occurs in the earth's crust in about the same amounts as lead and zinc, or 4 to 7 grams in each ton of earth. Unlike lead and zinc, however, there is very little natural concentration of germanium; and there has consequently been little economic exploitation of it.

No minerals are known in which germanium is primary constituent, though germanite and renierite contain it as a secondary metal. Renierite, which is found in the Belgian Congo, is available in sufficient quantity to make it now commercially attractive.

Most of the production of germanium in the United States is from the by-products of zinc smelting in the Missouri-Oklahoma-Kansas, or Tri-State, district. It is also found in coals in many parts of the world, but only in England has commercial manufacture proceeded from coal.

Germanium is usually considered as a metalloid, with properties between those of a true metal and those of a non-metal. It belongs to the class of semi-conductors, and is both divalent and tetravalent; the latter compounds are the more stable.

The metal is quite stable at 25deg. C, and is not affected by air, water, or oxygen; but at 600deg. to 700deg. C, oxidation in air or oxygen proceeds rapidly. Germanium combines readily with the halogens upon heating to form the corresponding tetrahalides. Chlorine reacts most vigorously, followed by bromine and iodine.

Hydrochloric and sulphuric acids have little effect on germanium at room temperature; but at 100deg. C, sulphuric acid will dissolve it slowly. Both nitric acid and aqua regia attack germanium, especially at higher temperatures.

Potassium or sodium-hydroxide solutions have little or no effect on germanium, but the molten alkalis quickly dissolve the metal. It forms two oxides, GeO and GeO2. The latter, germanium dioxide, is sold commercially.

In the recovery from zinc-sulphide ores, the zinc sulphide, which contains 0.01 to 0.015 pc germanium, is first roasted, then mixed with coal and salt, and sintered at a high temperature. Germanium, cadmium, lead, and some other metallic impurities are volatilised, and the vapors are condensed and collected in an electrostatic precipitator.

COMPLEX PROCESS

After some of the metals have been eliminated, copper-germanium remains as a precipitate, which is filtered off, and the solution is sent to the cadmium-recovery unit.

The germanium-bearing sludge is re-dissolved, and the germanium is concentrated by a second precipitation. The concentrate is then roasted and the roasted concentrate is dissolved in strong hydrochloric acid. Germanium tetrachloride, along with some hydrochloric acid and arsenic chloride, is distilled from this solution.

In the purification of germanium tetrachloride, the method which is used in the United States consists of multiple distillation in a batch or continuous process, with the final distillation conducted in the presence of chlorine and hydrochloric acid. The pure germanium tetrachloride is hydrolysed in distilled water to germanium dioxide, and then washed and dried with scrupulous cleanliness in order to avoid contamination.

The germanium dioxide is reduced to a powdered metal by heating to 650deg. C in an atmosphere of hydrogen. The powdered metal is then melted at 1100deg. C in an inert atmosphere to form billets.

For electronic uses, germanium is further purified by fractional recrystallisation. The metal, contained in a graphite boat, is melted in a horizontal tube furnace at 1000deg. C, either in an inert atmosphere or under vacuum. Upon being cooled slowly, the impurities concentrate at the two ends of the ingot, leaving the centre section relatively pure.

Additional recrystallisations of the centre sections of the ingot may be necessary in order to achieve the desired purity.

For the preparation of germanium for electronic devices, several processes are available.

In one process, single crystals of germanium are produced by "seeding" a melt of germanium (held only slightly above the melting point) and slowly withdrawing the crystal from the furnace. Other methods involve pressure, heating and quenching, or alloying with minute amounts of other metals. Alloying is usually done in an inert atmosphere or under vacuum.

GREATER PRODUCTION

By 1948, the production of germanium dioxide in the United States had reached 1000 pounds per year, rising to around 6000 tons in 1951. The Eagle-Picher Company is the principal producer, recovering it from zinc ore. The price of the metal in the United States is 340dol. per pound. The dioxide sells for 142dol. per pound. In electronic devices, however, the quantity used is small.

The first type of germanium device which became commercially important was the germanium diode, which is a fine wire of appropriate metal which presses against a thin wafer of properly prepared germanium, the complete assembly being only the size of a grain of corn.

The two-element unit acts as a crystal rectifier, and performs the same functions as a vacuum-tube diode, though consuming far less power. Germanium diodes are being produced at the rate of 7 to 8-million per year.

Germanium triodes, known as transistors, were invented in the Bell Telephone Laboratories in 1948. The first ones looked much like the diodes, except that two wires made

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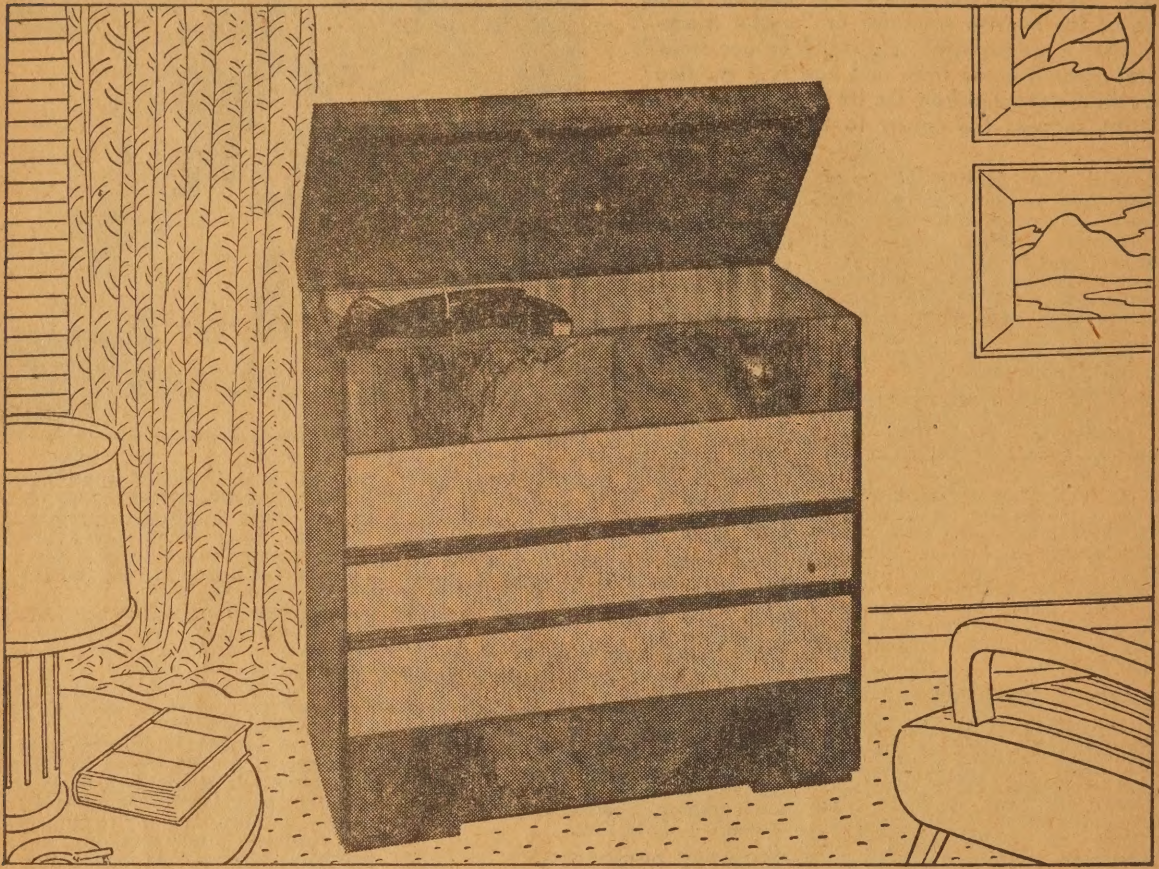

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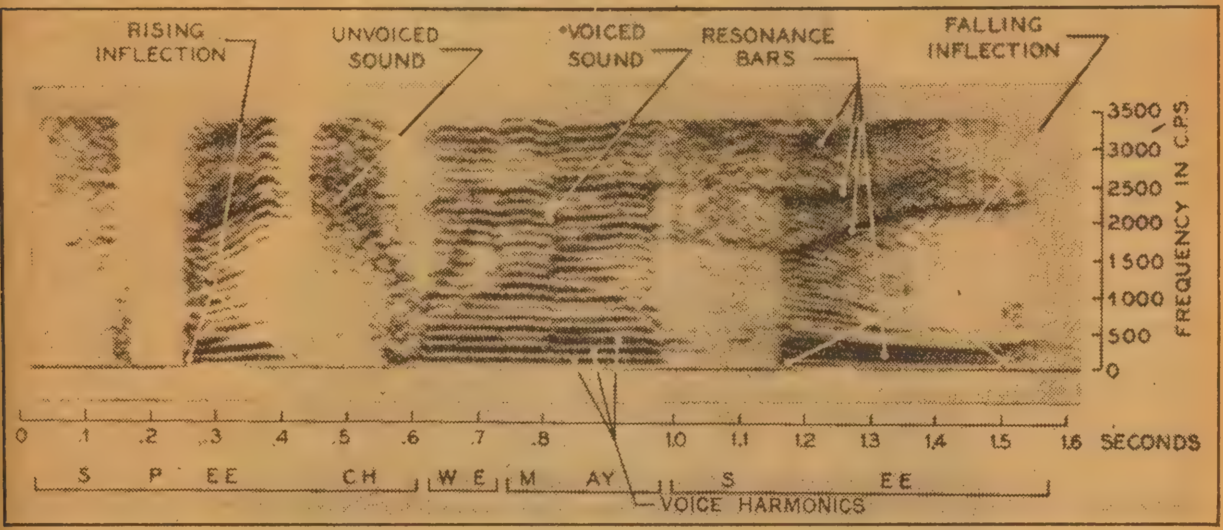
SCIENTISTS STUDY THE VOICE



A photographic record of the words "speech we see", showing the duration and energy/frequency content of the syllables.

During the month of March, two famous French specialists organised what was claimed to be the first major international congress to study the human voice and its maladies. They are Professor Andre Aubin and Dr. J. Tarneaud.

HELD at the Paris Faculty of Medicine, the Congress afforded ample proof that the modern "laryngologist" is no longer powerless against effects like stammering and loss of voice. By combining a knowledge of voice production and aural problems with modern psychology, a clear insight has been gained into many longstanding problems.

It has become abundantly evident that pathology of the voice cannot be isolated from pathology in general.

The voice involves the intelligence and the sensibility of the whole individual. It is connected with the brain, the nervous system, blood circulation, respiration, digestion and secretion by the glands. The diagnosis of a malady of the voice automatically implies a general examination of the individual.

TREATMENTS

As regards treatment, instead of keeping the patient in a passive state, it demands active co-operation of a psychological character.

Inhalation, spraying, electro-therapy and other forms of local treatment do not suffice to restore a voice that has been strained; re-education is needed as well and new co-ordination of muscular actions—all demanding a great deal of time of both patient and specialist.

Today, analysis of voice vibrations is conducted by the stroboscopic method which slows down a regular vibratory movement as far as is desired, by lighting at intervals a progression of segments of different vibrations.

Dr. Tarneaud's Stroborama, presented to the Academy of Medicine in 1933, is now the generally accepted instrument for the laryngologist. With it, laws of phonation have been discovered that result from connection between the vocal cords and the resonators of the larynx (at the lower end of the throat), the pharynx (the throat entrance) and the mouth itself.

Four basic types of voice have been found: the open chest voice, when the joining of the cords is rather longer than their opening; the closed chest voice, with a duller tone, when the joining is shorter; the falsetto voice with very short joining phase, and the whistling voice characterised by the permanent joining of the cords which only provide a very small hole for the air to pass through.

by Rene Sudre*

Important work carried out by Tarneaud and Husson has thrown much light on to the physiology of the pharynx resonator.

Many troubles of the voice and singing are the result of an irregularity of the larynx and its resonance cavities. The action of the pharynx on the larynx may not only affect the tone quality of sounds but change the "passages" in singing and demand a dangerous effort of the vocal cords.

There are many other possible anomalies of tone quality and they may sometimes be accounted for anatomically. Vowel nasalisation is due to malformation of the soft palate, but the absence of any nasal tone is caused by blocking of the nose. Speaking through the nose and guttural voice result from over-contraction of the pharynx and the contrary is true in the case of the toneless voice devoid of muscular tonicity.

Hoarseness comes from a lesion of the vocal cords and sometimes from bad functioning of the larynx. Defects of speech are called "dyslalies." Specific sounds may be articulated to a greater or lesser degree, or not at all. In other cases sounds are wrongly used in combinations of words and syllables.

Children are always dyslalic when very young and then correct themselves by force of habit. When the fault persists, it may be due to tardy mental development or to anatomic defects or to disorders of the ear.

Lisping is the faulty pronunciation of the sibilant consonants. It can be corrected, as can the other dyslalies, especially when treated in its early stages.

STAMMERING

Stammering, on the other hand is a neurosis and usually occurs early. It has been the subject of much study ever since ancient times, on account of the depressing social inferiority it gives. It is to be found in all peoples and mainly affects the male sex. A third of the cases are hereditary. Phoniatrists are divided as to its causes. It may correspond to psychical traumatism in early age, but it is not known whether it has connections with the brain. It can only be treated by psychological methods.

(Continued on Page 93)

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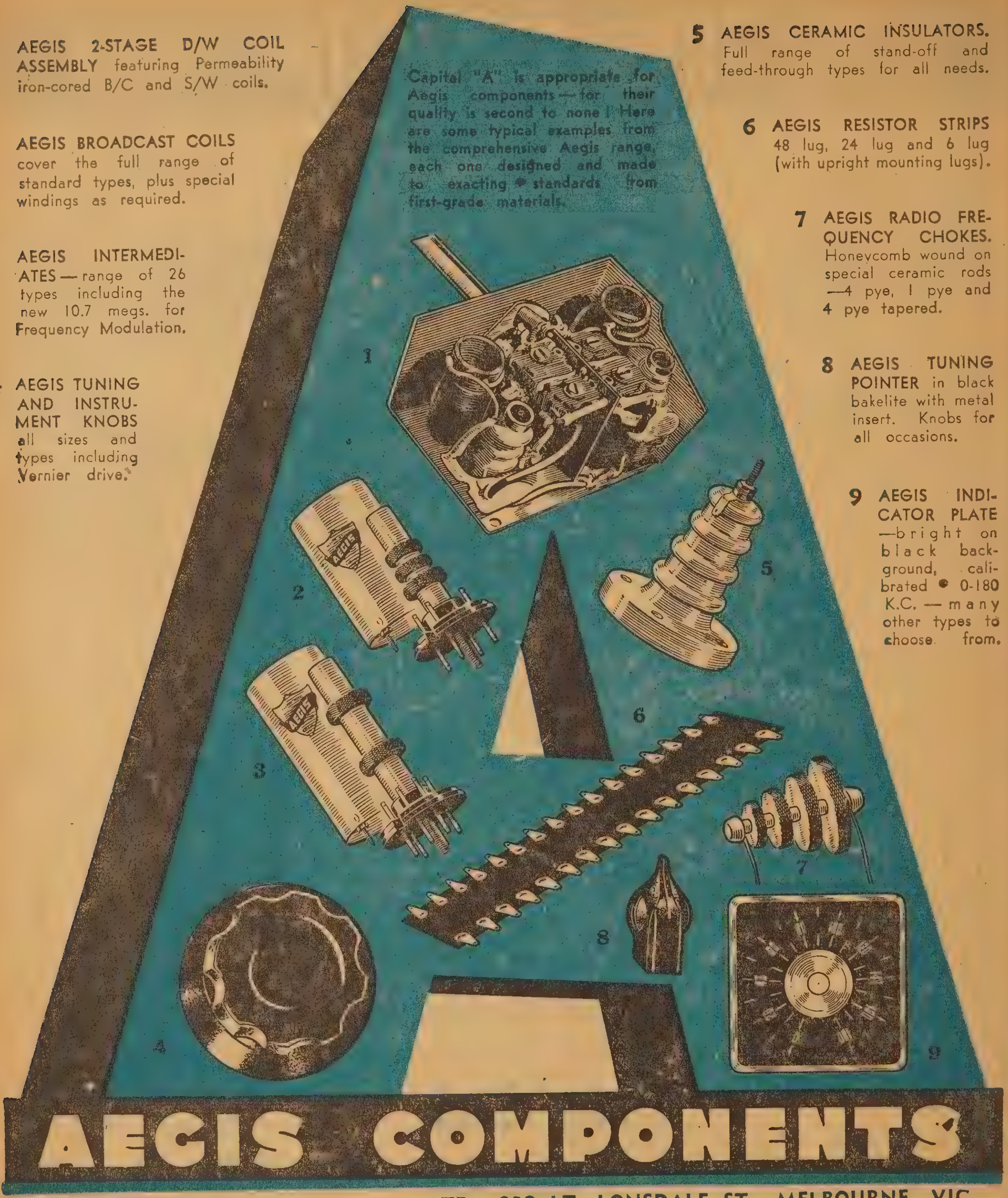

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RADAR FOR THE WHALING FLEET

Although some radar devices are still very much on the secret list, the more standardised items of equipment are daily finding new commercial application. Radar now sails deep into the polar regions with the world's whaling fleets.

IN the rugged days portrayed by Herman Melville in his classical Moby Dick, whaling was an industry peopled by characters almost legendary in their robustness, fortitude and exploits. Every foray into the formidable ocean was a gamble in ships and men, and accepted as such.

Lacking means of communication, the whalers and their crews were out of touch with land sometimes for six months or more. With only human eyes to detect their quarry, crew members were handicapped in spotting whalers in the broad, often fog-bound expanse of open water.

Radio and radar have changed all that. With modern steel whaling ships equipped with powerful radiotelegraph and radiotelephone systems, communication is available at all times between ships and between ships and shore.

KEEPING TRACK

Radar has proved invaluable in the search for whales and in keeping track of the small boats that scour the sea far from the mother ship. But the operations of the fleets are otherwise much as they were before the days of applied science. Despite technological advances, the battle between hulls, men, the seas and the world's largest mammals remains a thrilling saga.

When the whaling season begins in late autumn, whalers weigh anchor in swift squadrons. The big factory ship, "mother" to the fleet, races southward with smaller "catcher" vessels at her sides.

Once the convoy has reached the hunting grounds at the bottom of the hemispheres, the 1200-ton catcher vessels—far bigger than the factory ships of a century ago—leave the mother ship for the hunt, scattering for miles across the barren sea.

Through it all, the ships talk back and forth by radio, while radar—the silent sentinel—keeps constant vigil through fog and darkness, spotting the floating mesas of ice, preventing collision, keeping close contact with the vessels.

It is a common event for the mother ship and her flock to lose sight of each other in the swirling fogs. The smaller craft may develop engine trouble or run out of fuel. But today losses from these causes are rare. The hardy skippers and their men have learned to depend on radar with a deep feeling of confidence.

The Treen, a typical whale catcher, is one of a fleet of 55 vessels which has been equipped by RCA for a Norwegian firm. The radar antenna, indicated by the circle, is installed above the bridge deck.

But radar does far more than perform its function as a safety measure. Its usefulness begins soon after the familiar "Whale Ho!" sounds out from the lofty crow's nest of the catcher vessel. The harpooner first takes his place in the bow as the swift craft noses forward. Aiming his high-powered harpoon gun, he waits until the whale is in range, then touches the trigger. The grenade-headed harpoon streaks to its mark. There is an explosion, and in a few minutes the behemoth is dead.

At this point the catcher edges in and makes fast to the gigantic carcass. The body of the whale is inflated with compressed air to prevent it from sinking. Then a steel reflector rod, bearing the catcher's number flag and an electric light, is stuck upright in the side of the floating whale, after which the catcher goes on to seek further prey.

The floating carcass is soon located by radar aboard a corvette which tows the whale to the mother ship for processing.

When a full cargo of oil is ready, a tanker is summoned by radio. The oil is pumped into this vessel, allowing the factory ship to remain in the hunting grounds until the ice begins to close in and make further operations dangerous. Thus, in a good season, several cargoes of oil can be processed without requiring the mother ship and catcher boats to return to their distant home base.

A radio-equipped helicopter, leaving a wind-blown wake on the water, approaches a group of whales which have been inflated to keep them afloat. Each whale is marked by a steel rod, carrying a tag and a light and serving also to reflect radar pulses back to a searching antenna.

HELICOPTERS

One whaling fleet has successfully used the helicopter-radio combination to spot whales. The "flying windmill" scouts a wide front, sometimes 90 miles ahead of the fleet. From the air a spouting whale can be sighted 15 miles away on a clear day. Then a radio message from the plane directs a catcher vessel to the prey.

One helicopter, aided by radio, is reported to have sighted 560 whales in 60 days, 494 of them confirmed catches.

Some owners have equipped their entire fleet with radar. Since World War II, the RCA International Division alone has equipped more than 1000 ships of foreign registry with radar, of which approximately 150 have been installed on whalers operating in the Antarctic.

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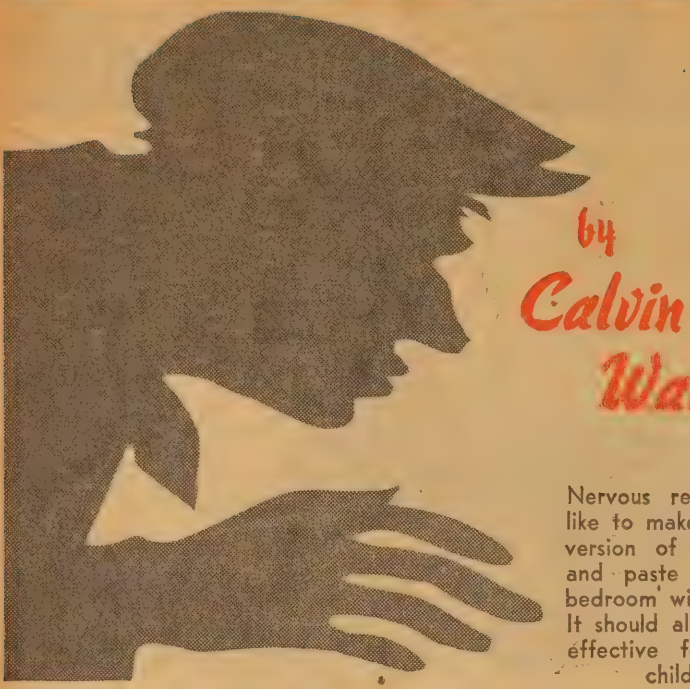


by
Calvin Walters

Nervous readers may like to make a life-size version of this sketch and paste it on the bedroom window-pane. It should also be most effective for nervous children.

SOLVING CRIMES WITH A CAMERA

The investigation bureaus of modern police organisations have extensive laboratories which make use of many branches of science to aid in the tracking down of criminals. Among the most important scientific aids to detection are photography and the microscope.

FILM fans are no doubt aware that there is always a swarm of photographers around the spot marked "X" where the body was found. They bring fantastic looking floodlights with them and the big, tough "D" will allow nothing to be touched until the photographers have taken pictures, not only of the body, but everything in the room or the immediate surroundings.

These photos are taken from practically every possible angle so that the smallest detail may not be missed.

Police photography is not like some of the motorists which the police pursue. It is not a "hit and run" business but must be carried out with scrupulous care to detail. The light must be right and the camera lens accurately adjusted. The angles from which the photo is taken must be worked out in relation to shadows cast by the light and so on.

TRUE PICTURE

In other words, great care must be taken to ensure that what the camera depicts was really so.

It is quite easy to make false deductions as, for instance, to dimensions, by having the actual length of a photographed subject confused by some shadow or color of the floor, mat or earth on which it is lying. Similarly, the surface character of a subject may be altered by shadows cast by slight irregularities. These can be greatly magnified by a light shining on its surface from too acute an angle.

False deductions may also arise through optical illusions to which the camera and the eye are subject.

An instance of this is the distorted view obtained through a window which is glazed with inferior glass. Most readers know of the effect of waviness and bending which takes place under such circumstances so that a witness could easily say that a burglar or murderer observed through a window and running away from the scene of his crime was bandy legged or hunch backed when in fact he was a person of normal physique.

EFFECT ON DISTANCE

Another illusion is that of distance which, to give a familiar example, is shown when the sides of a straight road converge and meet on the horizon. The same effect can be gained by taking a picture of the inside of a room with a camera of incorrect focal length. A small room can be made to look larger under such circumstances than it really is.

The correct film with which the picture is taken, extreme care in developing and printing and so on all play an important part in obtaining a picture which can be accepted as evidence in a court of law.

There is a rule which must be absolutely observed by the investigator of a crime. The object must not be moved or picked up or the room or location altered in any way until it has been photographed and minutely described in a report.

It is impossible in the scope of this article to cover all the aspects of police photography. It is intended to give a few examples of the means adopted to obtain photographic evidence of certain subjects.

Too many photos can never be taken. It is possible that they may not be required but there have been many cases where a crime has been solved by later examination of a picture which at first displayed no unusual features.

The position of an object in relation to other objects can have an important bearing on the matter. Careful consideration of the pictures at a later date can often throw much light on this matter.

Let us assume that a piece of cloth has been found in the fingers of a dead body. This was presumably torn from the clothing of the murderer during a struggle.

Two photographs will be taken. One will be of normal size while the other will be a magnified picture of the cloth to show the weave. This second picture will have had a rule placed on it before photographing to show the relative size of the weave.

From these photos is determined the character of the cloth, the type of weave and the number of threads per inch. If the cloth has been heavily dyed the dye is removed by chemical means so that the inner fibres can be photographed.

A description of the cloth is then circulated to manufacturers, etc and generally identification of the cloth is obtained which can then be used in conjunction with other evidence.

SPECIAL "LIGHTING"

The camera is very useful because of the property of the photographic plate to record things which are not visible to the naked eye, or at least hardly perceptible.

Most of this is accomplished by the use of infra red or other rays and plates sensitive to these rays. More will be said of this later. However, artificial means can often be used to make certain marks visible for photographing. For instance, tattoo marks often fade to invisibility because of bad workmanship, inferior colors or deliberate bleaching to avoid identification.

Tattooing is done by means of needles which are used to penetrate the skin so that dyes can be applied which go through the skin and so form the design.

These needles leave tiny scars, which are very difficult to remove. If lampblack is well rubbed into the spot where the old tattoo is suspected to be and the spot then lightly washed, the picture of the luscious blonde or what have you stands out clearly enough to be photographed. The only difference, of course, is that she is now a negress.

Another interesting fact is that the colors used in tattooing only penetrate as far as the lymphatic gland nearest the colors. The colors may have been bleached from the actual tattoo, but the lymphatic gland will still have the color in it. The particles of color are photographed through a microscope with transmitted light and color filters.

Every picture tells a story—especially if it has been taken by a police photographer at the scene of the crime. The camera records details which the most alert observer may overlook at the time.

If the eye stares from now until doomsday at, say, what looks like a blank piece of paper it will always look blank. To a photographic plate, however, the effect of light is additive, so that the longer the plate is exposed the greater the depth of shade obtained. Correct exposure, then, of a photographic plate will often reveal something which is not visible to the naked eye. Thus, this fact is made use of in bringing to light certain erasures in documents. Very often by these means the erasure is made quite visible on the photo.

Photography is of great aid in road accidents involving hit-run motorists. One case on record is that of a cyclist who was hit from behind. The rear wheel of the bicycle was wrecked and photographs taken showed that the hit-run car must have come in contact with the chain sprocket of the bike. A constable later noticed a car with the front number-plate on the bumper bar badly damaged. Investigation showed perforations as from a cog-wheel. It was found that the perforations fitted the sprocket of the bike exactly, with the result that the driver confessed.

"I DID IT . . ."

Another case was where a piece of enamel was found at the scene of the accident. Although very thin it was possible to take a picture of a cross section of the enamel through a microscope, whereupon it was found to consist of several layers of paint of different colors, which indicated that it had been painted several times during its history. Later a car showing obvious signs of damage was taken into custody. Examination of the paint showed that it had identical layers as the flake which was found.

Evidence of this kind is usually too much for the criminal and it often leads to a confession, which in this case it did.

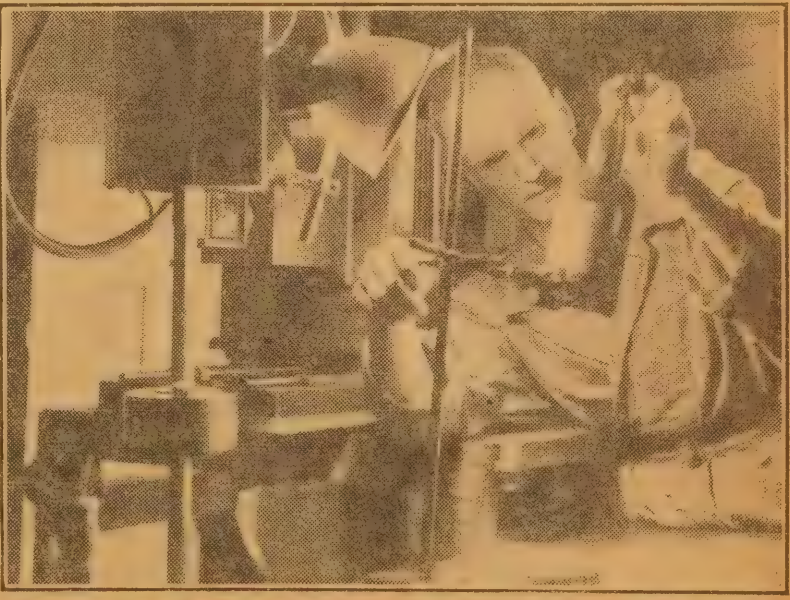
Needless to say, there is always a photographer on the scene at any bad road smash. Photos are taken of the skid marks, if any, and almost every aspect of the smash is recorded in this way.

In the identification of persons photography, of course, plays a major part. I am reminded here of the story of an escaped convict. This man, with a previous record, had a prominent place in the Rogues' Gallery. When he escaped his picture was circulated through all police stations. Those pictures showed the man from nine different angles. Some time later a zealous police officer from an outback country town sent a telegram to headquarters which read, "I have taken six of your wanted men into custody. The other three are under observaton."

In the art of fingerprint comparisons, photography has played the greatest part in bringing it to perfection. The ability to make side-by-side comparisons and to reproduce them on a very large scale for presentation to a jury is a very valuable contribution.

When it is desired to photograph a fingerprint on a colored article it is customary to bring up the print by dusting it with a powder colored complementary to the background. By then using the proper filter, the background can be rendered white in the photo.

An interesting problem involved the taking of fingerprints which appeared on both sides of a sheet of glass. The problem was solved in a rather ingenious manner. The prints on one side of the glass were dusted with a white powder and photographed on a black background. Those on the other side were dusted with a black powder and photographed on a white background.



Fingerprints on a bottle may reveal who last wielded it. Special lighting reveals to the camera marks which are invisible to the naked eye.

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"	347C	" "	GP.27
FERROCART	—	Pickup	GP.9
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" "	103	" "	GP.29
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" "	56	" "	GP.9
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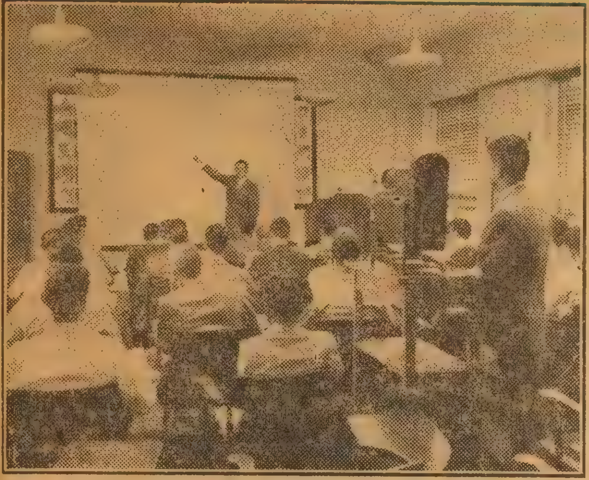
TRAINEES LEARN TO CLASSIFY FINGERPRINTS



Trainees and clerks in the FBI fingerprint division learn to classify fingerprints with the aid of slides and a projector.

On the job—a fingerprint expert uses a magnifying glass to determine the type of print and the number of ridges. The print is then filed accordingly.

In the case of prints on drinking glasses or bottles it is usual to fill the vessel with a dark liquid after dusting the prints with a white powder.

When a print appears on a mirror it is not so easy to get a good picture and recourse may have to be made to scraping the silver from the mirror behind the print so that there is no reflected interference.

Every now and again interest centres in what are termed "human glove" cases. These involve removing the skin from the fingers or hand of bodies which are in a state of decomposition. In such cases special methods have been evolved to meet the photographic requirements of obtaining a clear picture of the prints or other markings.

When the skin is hard and wrinkled it has to be softened with vaseline and perhaps melted paraffin injected beneath the surface to fill the bubbles caused by wrinkling.

When it is not possible to use this method, good results have sometimes been obtained by stretching the wrinkles with pins and photographing them in sections.

Sometimes the ridges on fingers of dead bodies have been worn down. The anatomical structure of the skin is such that the ridges are not confined to the surface, but penetrate deeper into the skin tissue beneath.

In cases of this kind the skin can be removed intact from the whole hand, turned inside out and inked in the ordinary way. The impression is taken on transparent tissue paper which is then used as negatives

When a body has been immersed in water for any length of time it is next to impossible to take prints by inking. One case is on record where skin taken from the fingers has been massaged with barium paste and the fingerprints taken by x-rays. Another method involves the stretching of the skin between glass plates and the photos taken by light transmitted through the back.

The use of ultra violet and infra red radiation is gaining great favor for detecting forgeries and erasures in documents and for identification of stains and so on.

When ultra violet light falls on certain substances these emit a visible light called fluorescence. Sometimes a perfectly plain-looking piece of paper may contain a message written in invisible ink.

Where a signature has been bleached from a document and written over for purposes of forgery it is easy to detect the erasure because most ink contains iron. Although the coloring matter will have been removed and the signature invisible to the naked eye, the iron remains in the paper and this will fluoresce under ultra violet light and become visible.

Inks used to print cheques and bank notes have their own characteristic radiation. If one of these is suspected to be of spurious origin it is merely a matter of subjecting it to ultra violet radiation.

Even the gum used on envelopes and stamps comes under review if at any time there is a suspicion that the envelopes have been tampered with.

If they have been opened and resealed, or the stamp removed and replaced, it will often occur that some adhesive will be required on the part of the law-breaker. The chances are that small blobs and patches of this extra adhesive will be enough to show a different fluorescence to the original.

Under infra red radiation it is possible to bring up for photographic purposes marks and blemishes in the skin which are not visible otherwise.

Scars and tattoo marks become visible. Certain underlying diseases of the skin which cause spots or discoloration become visible.

Thus, it will be seen that the lot of the law-breaker is not a happy one. He can be assured that he will not only be pursued in a physical sense, but that immediately his crime is discovered he will bring into play the full resources of science in its many forms.

GOOD SEASON OR A DROUGHT

(Continued from Page 7)

Forecasting Section of the US Weather Bureau for a month ahead. They are widely sought by American farmers.

Seasonal forecasting has been investigated in Australia for the last half-century.

Four years ago the Federal Government made a grant to the University of Melbourne for seasonal forecasting research.

A special seasonal forecasting unit was formed at the university in its Department of Meteorology to work in close liaison with the Commonwealth Meteorological Bureau.

After studying the various methods of long range forecasting, the members of the unit reached the conclusion that something akin to the German-cum-American method — modified for the conditions peculiar to the southern hemisphere—offered the best prospects of success in this country.

An exhaustive study, involving all the upper air observations in the southern hemisphere over the past three years is now being made. Reports from Australia, South Africa and New Zealand litter the desks of the unit's head (Dr. H. M. Treloar) and his team.

Former assistant director of the Royal Australian Air Force's wartime meteorological service Dr. Treloar is Australia's top authority on seasonal forecasting today

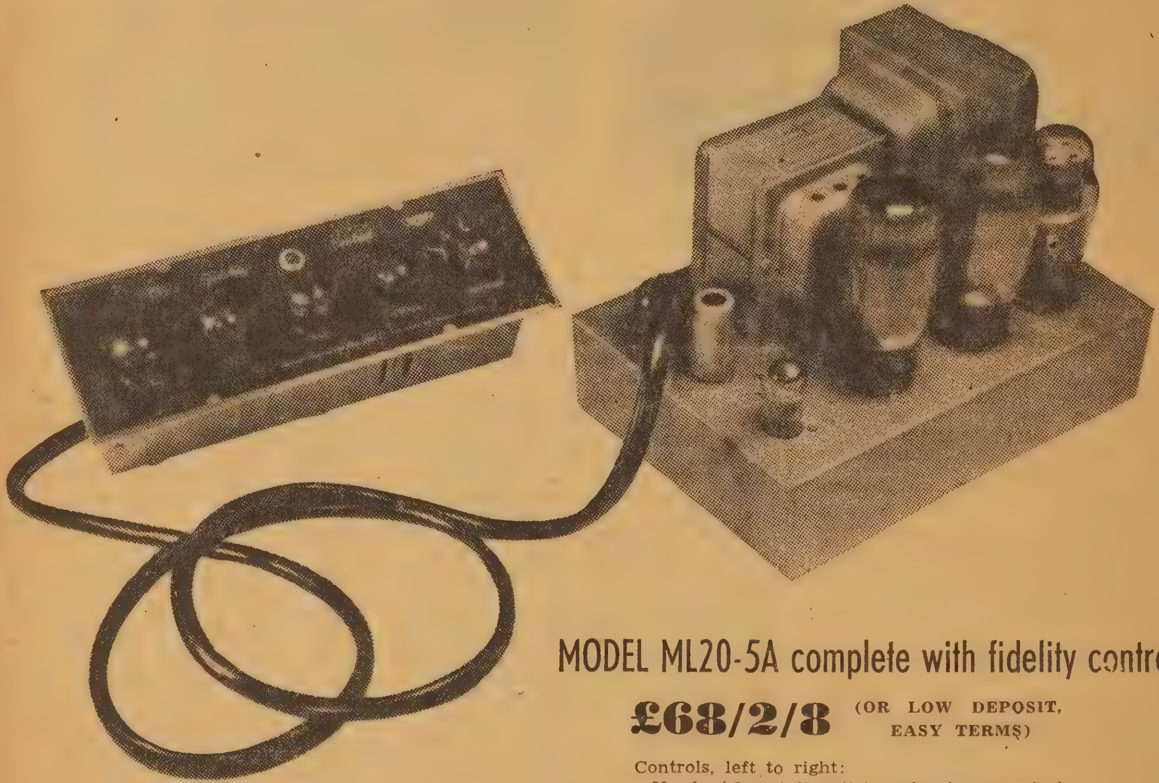
"If, and when our work will lead to actual long range forecasts can not yet be decided.

"Our work forms part of the fundamental research into atmospheric processes including sun radiation measurements, turbulence and general circulation and extended forecasting, for a few days ahead, now done by the meteorological service.

"All these studies daily add to our knowledge of the atmosphere but this knowledge will have to become much fuller before really sound long range forecasts can be attempted for Australia."

HEAR THE NEW ML20-5A HIGH FIDELITY AMPLIFIER . . .

The ML20-5A incorporates the new improved Fidelity Control Unit



MODEL ML20-5A complete with fidelity control

£68/2/8 (OR LOW DEPOSIT, EASY TERMS)

Amplifying unit — 20 watts output.

Valves: 1 x 6AU6
1 x 12AT7
2 x KT66
1 x 5V4G

Output Impedance — 2 to 4 ohms or 12 to 18 ohms. Supply Voltage: 220, 240, 260 volts AC 50 cycle supply.

FIDELITY CONTROL

Valves: 1 x 12AT7
1 x 12AU7

Inputs: Radio, microphone, pick-up.

Tuner power supply available.

Controls, left to right:

No. 1—AC on/off switch and volume control.
No. 2—Sharp cut off filter, Williamson type, 3 positions.
No 3—Bass control, rise and fall.
No. 4—Treble control, rise and fall.
No. 5—Input selector, 5 position.

Position 1: Radio.
Position 2: LP records.
Position 3: 78 American records.
Position 4: 78 European records.
Position 5: Microphone.

20 Millivolts input to pick-up terminals for 20 Watt output.

General: Compensation for record characteristics built into control unit, independent control of bass and treble. Sharp cut off filter for minimising scratch on old records without affecting operation of bass and treble controls.

Fidelity AE

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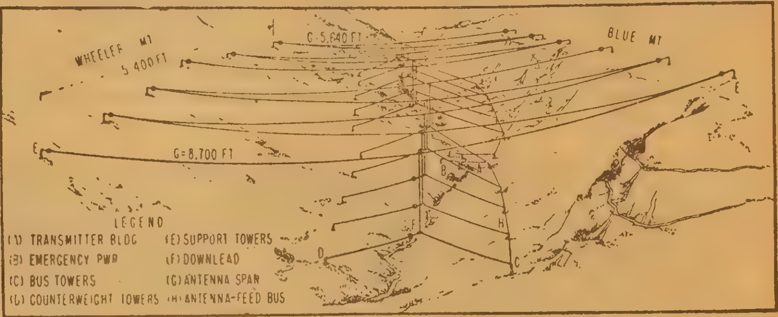
Technical Review

U.S. NAVY INSTALS WORLD'S LARGEST TRANSMITTER

Next spring the navy will commission the world's most powerful radio transmitter. Developing more than 1,000,000-watts in the very-low-frequency band, the transmitter will provide both c-w and teleprinter communications throughout the entire Pacific erea.



The antenna system consists of ten catenary spans arranged in zig-zag fashion. Downlead from centre of each catenary terminates in two spans. Antenna feed bus runs along south slope of valley. Towers on north slope contain counterweights that keep antenna system in tension.

ITS stentorian voice from Jim Creek will reach submarines cruising below surface and ensure reliable Arctic communications, despite frequent magnetic storms. Either c-w or fsk teleprinter operation is available. Its dual power amplifiers use push-pull 5831 triodes.

Antenna spans will be suspended between mountain tops to eliminate the need for high towers. These antenna spans or catenaries will vary from 8700ft to 5640ft in length, and from the midpoint of each span a 900ft download will be suspended.

NATURAL SITE

The transmitter site, Jim Creek Valley, near Arlington, Washington, is a natural for this type of antenna system. It is flanked on the north by 3200ft Wheeler Mountain and on the south by 3000ft Blue Mountain. The valley floor averages about 700ft above sea-level.

The station is 55 miles north-northeast of Seattle, 20 miles inland from Puget Sound.

The 1000-kw transmitter is contained within an enclosure 80ft wide and 50ft deep. The transmitter is actually a dual 500-kw transmitter arranged in the shape of the letter U.

The transmitter tunes from 14.5 to 35 kc and has been designed around the RCA type 5831 triode. Each of the two power amplifiers employs three 5831's, two in the push-pull circuit with the third available as a spare. The tubes are cylindrical, with disc electrode connections, and are about 10in in diameter and 20in high.

The anode, grid supports and cathode beam-former are water-cooled. The 6-volt filament structure of thoriated tungsten will require approximately 13-kw heating power. Each tube will require about 1200 to 1500 watts grid drive for 285-kw output at 80 pc plate efficiency. Plate voltage is 11.5 kv. The four operating tubes in both power amplifiers will deliver 1000-kw to the antenna system exclusive of helix losses.

The transmitter begins with a crystal-controlled and monitored oscillator, capable of on/off keying or frequency shift keying + 25 cps. By coaxial cable either of two such oscillators may excite either of the exciters that follow. Only one oscillator is in use at a given time on a single frequency.

NO TUNING

The exciters are a cascade series of R-C coupled amplifiers terminating in a cathode follower driving a pair of air-cooled 892R's. No tuning is required over the frequency range. Inverse feedback from the exciter output to input stabilises exciter gain and power output so that either one or both of the power amplifiers may be driven by either of the exciters.

The power amplifiers are push-pull circuits, with mica tank capacitors, litzendraht-cable variometer tank inductances and inductive antenna couplers.

An automatic tuning device is incorporated in each power amplifier and antenna half to maintain antenna resonance. The device receives samples of grid-drive and antenna current in each half of the antenna, and compares the phases of the sample voltages. Departures from the phase relationships at antenna resonance will cause thyratrons to conduct so as to control rotations of the antenna-tuning variometers in a direction to restore resonance.

Total antenna current is expected to be just over 2100 amperes. Antenna insulator voltage will be in the order of 240-kv.

The intense electromagnetic field around the transmitter necessitates an elaborate grounding system for the entire structure, including copper shielding and a ground screen around the building.

WHY U.S. NAVY CLINGS TO VLF

VERY-LOW-FREQUENCY waves behave as though they were propagated in the space between two concentric reflecting spherical shells representing the earth and the lower edge of the ionosphere.

Their propagation is characterised by very small ground-wave attenuation, particularly at the lowest frequencies, very slight sky-wave penetration of the ionosphere, and relatively small energy absorption in the ionosphere, which also decreases with frequency. Losses increase during magnetic storms but the effect of these storms is less pronounced as frequency is decreased.

With its 1000-kw vlf transmitter, the navy expects to radiate a strong signal into the extreme reaches of the Pacific Ocean and to maintain constant contact with ships in the far north, despite frequent magnetic storms that cause radio blackouts of high-frequency signals.

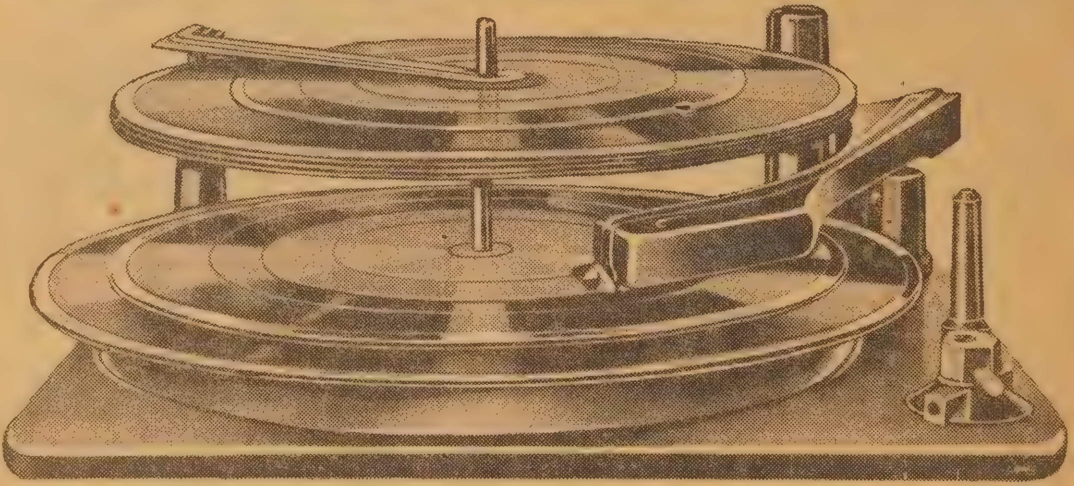
Very-low-frequency waves also penetrate the ground and sea for a considerable distance. Patrolling submarines, including those of the atomic-powered variety, will never need break surface to receive their orders from Big Jim.

Already . . .

A SENSATIONAL SUCCESS!

BSR

3-speed AUTOMATIC RECORD CHANGER



7, 10, 12"
DISCS
ALL-CHANGE
INTERMIXED!

Technicians and music lovers, manufacturers and hobbyists, have all acclaimed this new B.S.R. Masterpiece! The simplicity of desigh, the new change mechanism, the robust construction and ease of operation, the **extended frequency response to 10,000 c.p.s.** — all these combine to make the "B.S.R." the finest automatic record changer available today!

ALL SPEEDS
78, 45, 33⅓.

It's the MICROGROOVE Changer with the 8-Star Features!

- ★ Automatically selects and plays 7in, 10in, and 12in records, intermixed, at 33-1/3, 45 or 78 r.p.m. Capacity, 10 records.
- ★ New record change mechanism virtually eliminates pause between records.
- ★ New reversible dual stylus crystal pick-up has extended frequency range to 10,000 c.p.s. Self-compensated for the L.P. lower frequencies with the Turnover frequency at the correct point
- ★ Pick-up automatically returned to rest position and motor switched off after last record.
- ★ Remarkably compact design makes it an ideal unit for any style of Radiogram combination.
- ★ Simplicity of design guarantees long life and trouble-free operation.
- ★ Beautiful styling and finish that will harmonise with any cabinet design.
- ★ Operates on 100/125-200/250 volts, 50 cycles A.C. Models (also available for 60 cycles A.C.).

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£26
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TV PROGRAMMES RECORDED ON MAGNETIC TAPE

Our last issue carried a news item to the effect that Bing Crosby Enterprises had successfully demonstrated TV recording—both sound and picture on magnetic tape. A preliminary story on this new development appears in the latest issue of "Broadcasting, Telecasting".

WRITTEN by Frank Healey, executive director of the company, the article tells the story of the group's work on the project.

Under the leadership of our chief engineer, John T. Mullins, practical video tape recording has been accomplished after only three years of research and experiments.

The first VTR (Video Tape Recorder) unit was demonstrated in late 1951 in our Hollywood laboratories at 9030 Sunset Blvd., Hollywood. This unit was sufficiently advanced in the degree of picture definition during last year to foreshadow the manufacture of recording and playback equipment capable of answering the demands of the television and motion-picture industries.

It may now safely be declared that such a commercial unit will be available within a year, despite predictions that success would not be achieved for five or 10 years.

COLOR TV

In addition, no problem is anticipated in handling color when it is introduced to the TV industry. Tests indicate that VTR will be readily adaptable to any of the color systems now being considered.

Without dwelling in detail on the technical phases of the development or describing the highly involved circuit pattern of our recorder, we can reveal, for the first time, the general specifications of the recorder and how it operates.

In physical appearance it is similar to the tape sound recorder, with which everyone in the radio-TV industry is familiar. To produce a sound-picture tape outwardly appears as simple as the recording of sound alone.

This is the way a VTR functions: A one-inch tape, similar in outward appearance to that now employed on commercial tape recorders, is used. Sound recorders run at 15 inches per second. Our recording speed for video is 100 inches per second.

The reason for the high speed is that our engineers have demonstrated the possibility of recording under these conditions 260 times the "information" that has heretofore been possible to capture under any tape system now in general use. Even so, a non-bulky roll adequately provides for recording a 15-minute program.

TWELVE TRACKS

In "scanning" the video picture to our tape, we record on 12 tracks—one for sound and 11 others for picture.

Tape in present use is made by Minnesota Mining and Manufacturing Co. It is composed of an acetate base material coated with a special magnetic oxide. A new base will shortly be produced by this company. It will be known as "Mylar," a development of duPont. Although thinner, it will be a stronger tape.

Also in preparation is a half-inch tape of thinner stock, which will assimilate all the electronic pulses now recorded on our one-inch tape.

In a typical operation, the sound and picture to be recorded on magnetic tape are picked up in a studio by the normal video procedure of the TV camera and microphone.

Through the camera and sound equipment, an electrical signal is transferred by coaxial cable to the recorder. The machine may be on the stage where the picture is made, in a sound truck, or at a laboratory some miles distant.

The recording is taken instantly, but, by inclusion of a built-in playback device or "monitor," the taped picture and sound may be inspected visually and audibly only one-tenth of a second later on this close-at-hand viewer.

IMMEDIATE "PLAYBACK"

Here is one of the many tremendous advantages of the system. An immediate view of an originating production is made available. There is no delay of processing, such as is necessary in motion picture filming. Thus the program producer or supervisor, in the case of a TV production, may be immediately assured that the recorded program is without flaws. Eliminated are tape rewinding, later inspection on playback and such delays as viewing the "rushes" on the following day.

It is conceivable that a director or producer sitting in his Hollywood office might supervise production of a play at Rockefeller Center, in New York, as efficiently as though he were present on stage there.

He could take and retake scenes, without intermittent delay, to suit the demands of his personal taste and assure himself of immediate satisfaction with program quality. Editing and timing would be merely a matter of a watch, a pair of scissors and some Scotch tape.

The program, now having been taped for later telecast, needs only to be passed through the VTR. The playback machine which previously was the recorder, now "reads" back the recording, recreating what the video camera saw and what the microphone heard. This picture and sound may be fed to the TV transmitter or simultaneously distributed via coaxial cable or micro-wave, to other areas.

One of the greatest advantages of VTR is the cost comparison. Our device will record for 50 dollars the 15-minute 35mm "hot kinescope" that now costs some 150 dollars to produce. A regular 30-minute kinescope negative and one positive on 16mm film now cost some 600 dollars to produce.

A top view of the tape deck for TV record and playback. First public demonstration was said to lack definition but Crosby Enterprises claim that adequate reproduction standards can be achieved.

The Crosby VTR promises a quality picture and virtual permanence for 100 dollars, with additional dupes at the same price in any quantity desired, without loss of fidelity.

Tape may be de-magnetised and re-used, thus effecting savings in material costs.

Fades, dissolves and special effects may be recorded without use of optical printers or special effects equipment. Since sound recording is coincident with that of picture, the dubbing process is eliminated.

LOWER COST

VTR tape will cost one-fourth to one-tenth less than motion picture film. The one-tenth of a second viewing after filming of results through the monitor will result in time and material savings, since errors may be immediately detected and corrected.

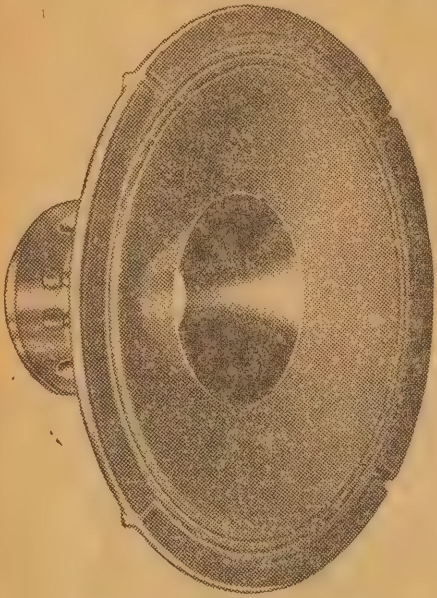
These glowing promises of great savings in production costs naturally give rise to one final question: What will the Crosby VTR cost?

A complete unit, with recording and play-back, will sell for approximately 50,000 dollars, according to present estimates. It is contemplated that production of these machines will be under licence to Ampex Electric Corp.

Whether the machines will be sold or leased to TV stations, networks and motion picture studios is yet to be determined. Present progress indicates that the machines will be available by January of next year.

JUNE OPPORTUNITIES at Audio Engineers

YOU ARE WELCOME TO VISIT OUR SHOWROOM AT NO OBLIGATION . . .

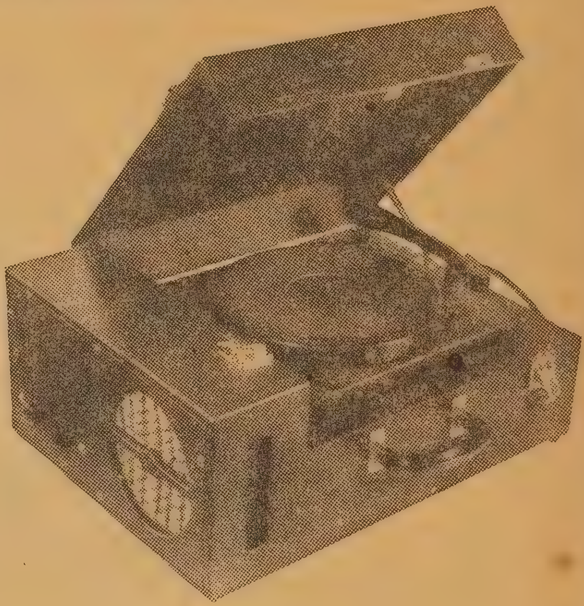


THE NEW GOODMANS AXIOM 150 Mark II LOUDSPEAKERS NOW AVAILABLE
35 Cycle Cone Resonance

GOODMAN'S AXIOM 150 LOUD SPEAKERS

£22'3'6

For wide range reproduction the Axiom 150 is the most suitable. Its frequency response covers the range from 40 to 15,000 cycles.



MODEL PAG 8

Portable Record Players complete with Amplifier and Loudspeaker. Using the famous BSR 3-speed Motor and crystal pick-up fitted with Turnover Cartridge. **£27'10'-**

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EXPERIMENTS WITH A TETRODE TYPE TRANSISTOR

Experiments at the Bell Telephone Laboratories have shown that, if a fourth electrode is added to a conventional junction transistor, and biased in a suitable way, the base resistance of the transistor is reduced by a substantial factor. Because of this reduction in base resistance, the transistor may be used at frequencies ten times or more higher than would otherwise be possible.

TWO other factors that are responsible for the improvement in high-frequency response are that the cutoff frequency of the current gain has been increased by using thinner "p" layers and that the collector capacitance has been reduced by decreasing the area of the collector junction.

The fourth electrode, designated b2, is connected to the "p" layer in the same manner as the base connection is made, but on the opposite side of the bar (Fig. 1).

Performance of the tetrode transistor, is under the conditions of a fixed current bias 1b2 applied between the base and the added electrode. A suitable value of this bias makes the potential of b2 6v with respect to base.

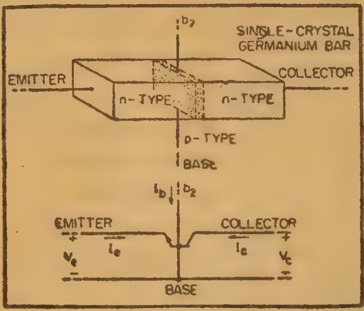


FIG. 1—The tetrode structure and the symbol used to represent it.

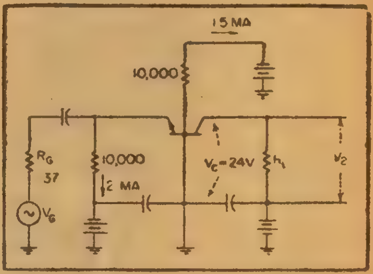


FIG. 2—Transistor tetrode used as a grounded-base amplifier.

NORMAL BIAS

Emitter and collector electrodes are biased about the same as in conventional junction transistors.

With these operating conditions, the part of the emitter junction near b2 is biased in the reverse direction and does not emit electrons into the "p" layer. That part of the emitter junction in the immediate vicinity of the base contact is the only part of the emitter junction biased in the proper direction to serve as an emitter.

All the transistor action, therefore, takes place near the base contact, and this fact accounts for the reduction in base resistance rb, and the resultant improved high-frequency performance.

Good high-frequency properties are not dependent on a critical setting of b2 bias. All values between 1 and 2mA have been found satisfactory.

For one particular junction transistor tetrode, with no bias on b2, the base resistance was 1100 ohms. As -1b2 was increased to 2mA, rb decreased to about 40 ohms. As -1b2 was increased from 0 to 2mA, current gain decreased from 0.99 to about 0.75, causing an increase in band width at the expense of gain.

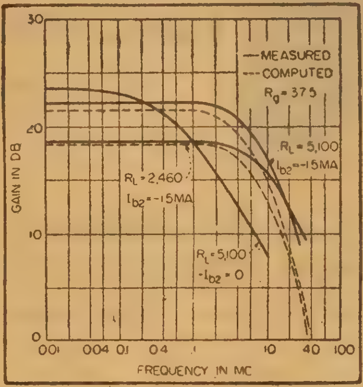


FIG. 3—Measured and computed gains for the circuit shown in Fig. 2.

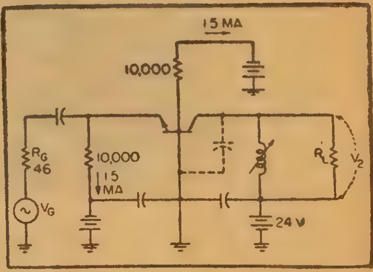


FIG. 4—Simple tuned amplifier circuit.

ACTUAL RESULTS

Measured response of this transistor in the circuit of Fig. 2, is shown in Fig. 3. With R1 = 5100 ohms, the gain is 22.3db and the 3db point is at 5 mc. This is comparable with the performance of good vacuum tubes. If the transistor is used as a triode in the same circuit by making -1b2 equal nought, the cutoff frequency is reduced to approximately 0.5 mc.

As shown in the lower solid curve of Fig. 3, reducing R1 to 2460 ohms raises the cutoff frequency to 10 mc, and reduces the low-frequency gain to 18.4 db.

If a grounded-base amplifier is driven by a resistive generator, the output impedance of the amplifier looks like a resistance and a capacitance in parallel.

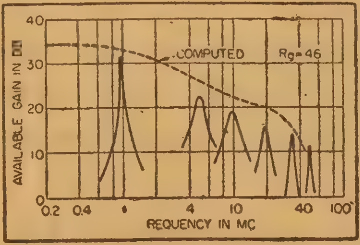


FIG. 5—Peaks of these response curves show the available gain in the circuit of Fig. 4. The dotted curve shows the computed focus of the peaks.

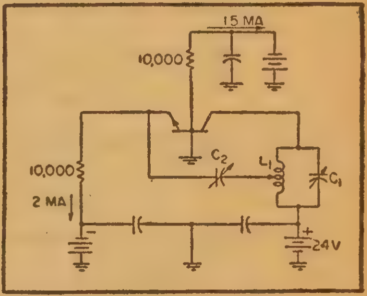


FIG. 6—An oscillator circuit suitable for use with junction tetrodes.

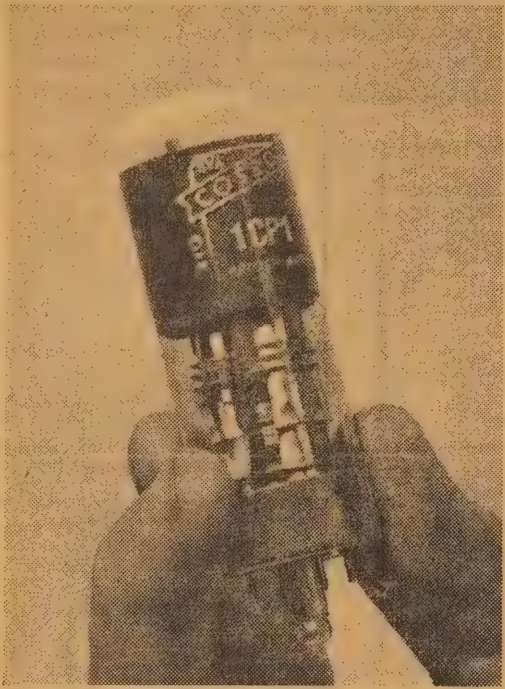
If the amplifier is loaded by a shunt inductance and resistance as shown in Fig. 4, the inductance will resonate with the output capacitance to give a peaked response. Maximum gain will be obtained at the frequency of resonance when R1 is adjusted for match.

The curves shown in Fig. 5 were obtained by varying the load inductance to obtain various resonant frequencies and then adjusting R1 at each frequency to give maximum gain. Measured gain at 50 mc, 11.8 db.

The circuit of Fig. 6 was used to observe the performance of transistor tetrodes as oscillators at high frequencies. Provision is made for adjusting the value of capacitance in the feedback path to the emitter. At higher frequencies, the input impedance at the emitter tends to become inductive and it is necessary to adjust the capacitor.

Most of the tetrodes used in this circuit produced sinusoidal oscillations up to frequencies as high as 80 to 100 and 130 mc. Between 40 and 75 mc, measured output was approximately one milliwatt for one transistor. At 100 mc, output is 0.25 milliwatt and at 115 mc, 0.06 milliwatt. Collector dissipation was held to about 30 milliwatts during the measurements. (From Electronics.)

COSSOR



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DATA

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Screen diameter	25 m.ms.
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Heater current	0.6 amps.
Anode Volts	500/800
Max. grid bias	-21/-32 Volts.
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NEWS AND VIEWS OF THE MONTH

How to bail out

THE Royal Air Force is using a 45ft mobile tower to teach its pilots how to position themselves for protection should they have to get out of a doomed jet aeroplane.

In addition to getting a "pretty good idea" of how it feels to be ejected from a speeding jet plane, the pilot also learns how to position his head so that his backbone will not snap under the forces that eject him.

The towers are equipped with special ejection seats attached to guide rails. The pilot is fired up the tower by a cartridge under the seat. A ratchet device catches him at the top and lowers him safely to the ground.

Measuring speed

NAVAL engineers secretly determined the "ground speed" of the shiny new superliner SS United States through a modified electronic tracking system used previously to follow the wanderings of high-flying weather balloons.

Reporting to the Society of Naval Architects and Marine Engineers meeting in New York, J. P. Comstock, assistant naval architect at the Newport News Shipbuilding and Dry Dock Co., and C. E. Hastings, president of the Hastings Instrument Co., Newport News, Va., said the system prevents unauthorised persons from figuring out the ship's speed during tests.

Extremely accurate, the system replaces the "measured - mile" course over which ships usually are clocked during speed tests. Only two such courses are widely used on the eastern coasts of North America and Cuba. Neither was satisfactory as a test site for the United States.

The Raydist system, as it is called, has these advantages over the measured-mile course:

It can be used in "truly deep" water, whereas the measured-mile course must be visible from the shore.

Spinning to death

MEDICAL scientists are spinning dogs and men like pin-wheels to study what happens to jet pilots forced to bail out at supersonic speeds.

Pilots who bail out go into a violent head-over-heels spin in the aircraft's slipstream, turning at rates higher than 100 revolutions a minute until their parachutes open.

The result may be a "woozy" feeling, like a hangover, which lasts for days. There is also a risk of permanent damage to heart and blood circulatory system.

These facts were given to the annual meeting at Chicago of the Federation of American Societies for Experimental Biology by Captain Harold Weiss, Captain Robert Edelberg and Lieutenant Paul Charland, researchers at the air force aeromedical laboratory at Wright Field, Ohio.

The three scientists told of spinning human volunteers and anaesthetised dogs in experiments to find out what had happened to dead jet-fighter pilots without a mark on them who had drifted to earth by parachute.

The terrific spinning, they found, set up centrifugal forces which drove the blood out of the central organs, including the heart, and to the head and feet.

Spinning at more than 100 revolutions per minute, if continued for more than a few seconds, built up blood pressures in head and feet high enough to cause hemorrhages. In the central organs the pressures fell far below normal.

In a spinning man the centre of rotation was the abdomen. Hence the abdominal organs were all emptied of blood.

Some blood remain in the heart and lungs and the common result of spinning was loss of consciousness rather than death.

However, no human being could stand spinning at 100 revolutions per minute for a full minute. Spinning at higher rates, such as 140 revolutions per minute, produced unconsciousness within a few seconds.

Tides in atmosphere

IT had been discovered that the moon caused "tides" in the upper atmosphere as well as in the oceans, a US Government scientist said recently.

The scientist, Dr. A. G. McNish, of the National Bureau of Standards, said the discovery offered new aid to international radio communication.

He said that "high tides" of electrons took place twice a month high above the earth—being highest four days after the moon's first quarter and four days after its last quarter.

POPULAR SCIENCE QUIZ

Q: What is the Nandi Bear?

A: It is one of Africa's unknown animal monsters — unknown officially, that is. There are European residents in Africa who refuse to believe in the existence of the animal, and dismiss it as a figment of native superstition. On the other hand, there are European residents of many years standing in experience in Africa's mysteries who believe in the Nandi Bear.

According to the reports, it seems to be a great brownish or yellowish bear-like creature. Armed with long claws, it hunts at night in a silent but very ferocious manner. It has been known to kill pigs, cattle and even humans. It has been recorded of the bear having burrowed through eight-foot-thick walls of thorn bushes and even to have jumped over a six-foot fence carrying a sheep in its mouth.

Its cry is described as a loud, roaring screaming noise. Guided by the information available on its description and the tracks left by the bear, it appears that it is something unknown to zoologists.

Q: What is a geophone?

A: A geophone is a vibration pick-up device used in connection with a seismograph for the recording of vibration through the earth's crust. It is used by geophysicists in determining rock formations in the earth's underground structure and usually in searches for oil-bearing rock.

Firstly, a small-diameter hole is drilled to a depth of between 20 and 150ft through soil and rock at the surface and a suitable size explosive charge is fitted into the hole, which is then filled with water. A number of geophones (actually a special type of sensitive microphone) are placed just under the surface dirt at intervals of a few hundred feet on a line leading away from the "shot" line. These are connected to a suitable recorder which records the subsequent vibrations on strips of tape or paper.

The recorder is set in operation and the explosive charge is fired electrically. Although the initial heavy surface wave runs the recorder to its limit, the subsequent echoes from deeper rock layers arrive to be recorded on the tape strip marked off in time intervals, usually of .01 second. From this recorded time delay of reflected vibrations from the subterranean structure, the geophysicists can build a clearer picture of what lies under the outer soil before a huge expensive drilling program is undertaken.

Q: What is a "Beta Gauge?"

A: It is a device used to measure the thickness and weight of paper, plastics, metal and similar products which are kept moving in sheets or strips during the manufacturing process.

Developed by the Tracerlab, Inc., with the assistance of scientists from Oak Ridge, USA, the gauge functions on the principle that a moving strip or sheet will absorb an amount of radiation proptional to its weight when placed between a source of radiation of beta rays and a radiation detector When used with an appropriate electronic recorder, this function can be converted to give an automatic and continuous indicaton of the thickness of the passing sheet.

Experts have hailed Rola Models 12-0 and 12-0x as the world's finest loudspeakers in their class and vastly superior to many more expensive types.

Specifications

MODEL 12-0

Power Handling Capacity	7 watts
Fundamental Diaphragm Resonance (F29)	75 c.p.s. ± 5 c.p.s.
Frequency Range	70 c.p.s. — 8 k.c.
Voice Coil Impedance at 400 c.p.s.	2 ohms

MODEL 12-0x

Power Handling Capacity	6 watts
Fundamental Diaphragm Resonance (F30)	50 c.p.s. ± 5 c.p.s.
Frequency Range	45 c.p.s. — 12 k.c.
Voice Coil Impedance at 400 c.p.s.	2 ohms

Model 12-0 was designed for use in high quality radiograms to reproduce 78 r.p.m. records with fidelity and realism. The later Model 12-0x catered for "wide range" enthusiasts who were prepared to use the most expensive types of pick-ups and amplifiers.

Model 12-0x is too fine a loudspeaker to use with ordinary equipment, but the advent of L.P. discs made desirable a loudspeaker possessing a top response between that of 12-0 and 12-0x. Rola met this with a 12-0 fitted with a special F29 diaphragm giving a very even response to 8 k.c. This new 12-0 is the practical answer to the problem of getting maximum performance from standard equipment although it should be stressed that, as with any extended range loudspeaker used for record reproduction, it is essential to use a pick-up the response of which is free from peaks and undesirable resonances. The improved Model 12-0 can be identified by its diaphragm which has five concentrically spaced corrugations and a glossy finish to its rim.

Model 12-0x is *still* Australia's finest extended range loudspeaker, but the new 12-0, with its F29 diaphragm, does an equally fine job in the field for which it was designed.

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Commercial and military radio stations transmitting over long distances could take advantage in this way:

At certain times of the month corresponding to the lunar atmospheric "tides," they could utilise additional "channels" of radio communication at high frequency ranges without fear that these very short radiowaves would be "lost" in the outer atmosphere.

He said the new finding could extend by 25 to 30 pc the number of usable frequencies now employed in long-range international broadcasting.

The atmospheric "tides" provided by the moon resulted in dense layers of highly-excited electrical particles which could reflect back to the earth radiowaves that at other times in the month might escape into space

Islands of ice

THE United States Air Force had landed two scientists on the Ellesmere ice shelf near Greenland, in the first step of a joint venture with Canada to learn the origin of the great ice islands that shift about in the Arctic.

The air force said the scientists, both Canadians, an Eskimo sled driver and 10 dogs were left on a sheet of ice 10 to 15 miles wide along the north-west coast of Ellesmere Island.

The huge island is west of Greenland, and its bordering ice shelf is estimated to be 100 to 200ft thick.

The air force said the expedition would try to learn whether Ellesmere's ice shelf was the original point of Fletcher's Island, a floating mass of ice near the North Pole, on which the air force had operated a weather and Arctic research station for more than a year.

Efforts would be made to estimate how rapidly the ice shelf grew and predict when future ice islands will break away.

The scientists would explore the area and place markers preliminary to a larger investigation now planned for April, 1954.

Supersonic war

RESEARCH scientists have revealed that they were working on guided missiles which may attain speeds of up to 15,000 miles an hour

They also disclosed that rocket-powered models of tactical planes and missiles were already being flown at speeds of more than 300 miles an hour.

Government and military leaders were given a report on the latest research progress at an inspection of the Langley laboratories of the National Advisory Committee for Aeronautics.

The 15,000-mile-an-hour missiles, still in the research stage, are reported to be long-range weapons designed to operate within the earth's atmosphere.

Mr. Floyd Thompson, associate director of the Advisory Committee for Aeronautics, said today that "gigantic" problems still had to be overcome before practical supersonic combat aircraft were developed.

Designs which permitted piloted planes to attain speeds greater than that of sound have brought problems "so serious in many cases that pilots are unable to control the aeroplane.

He added that rocket-powered models were being used to solve the problems without endangering the life of a pilot.

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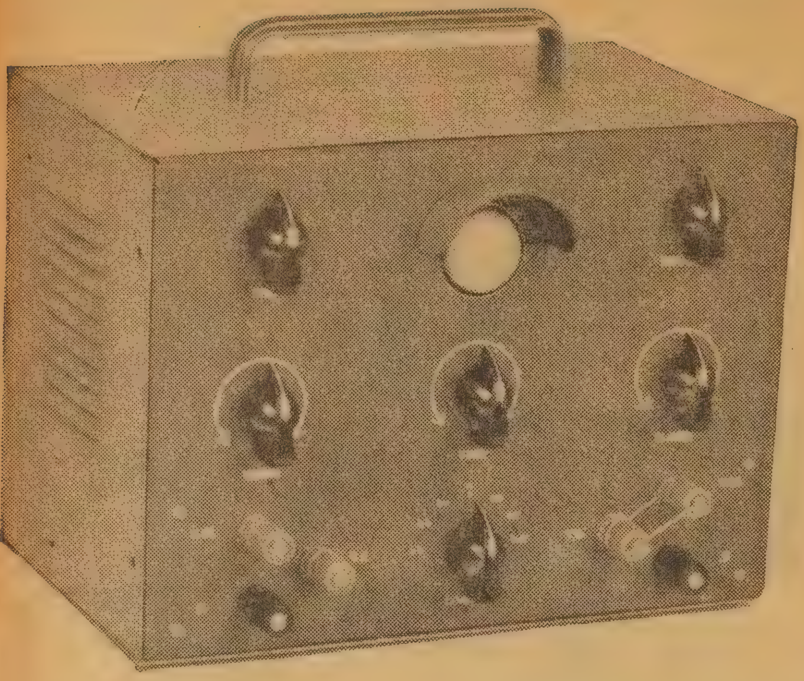


This view illustrates the compactness of the unit. The controls are "synch", "vert. amp. gain" from top left down. In similar position on the right are the "intensity" and "hor. amp. gain" with the "time base fine" and "time base coarse" in that order beneath the CRT screen. The terminals at lower left and right are input for the amplifiers, output from the time base and direct connection to the free vertical plate.

THE "R & H" 1-IN. OSCILLOSCOPE

A simple, cheap and portable CRO has a place in any workshop or on any test bench. Our new 1in oscilloscope will perform most functions of its larger brothers from audio testing to modulation checking in transmitters. Take a look at the circuit and you will want to build this unit, even as a backing to an existing larger CRO.

by Raymond Howe

OVER the last few years, when war disposals supplies were at their peak, 5BP1's and other cathode ray tubes became, for a very modest outlay, the property of thousands of radio enthusiasts and bread-and-butter winners.

During this extensive period, we described several 5-inch, 3-inch and 2-inch CR Oscilloscope circuits for this very reason, mindful though we were of the 17-odd inch lengths of some of these tubes. There were many who overcame the physical disadvantage of the lengthy CRT by setting it vertically and viewing waveforms with the aid of a mirror mounted at 45 degrees to the tube face.

HARD TO MOVE

Such arrangements suit quite well for a fixed installation, but what of the reverse situation? It involves sheer manual labor to move a large CRO from point A to point B, apart from the awkward need of finding space for it on the bench when it arrives.

We have always had a yen—and a —use—for a small simple portable CRO which would satisfactorily do the work of a large CRO, but which could be moved around with as much ease as a multimeter and take up about as much space.

We feel that the time has come to present a small compact unit, because the supply of large disposal CRT's is drying up and supplies of new ones from manufacturers are virtually non-existent.

Our mind was made up to go ahead with the idea when we became aware of stocks in Australia of an English self-focusing CRT of a 1-inch screen diameter. Accordingly, we produced a preliminary set-up based on a few ideas we had on the matter, and we were agreeably impressed with the workable presentation available from this tube. We could see our original thoughts of a year or two ago taking shape.

OLDER TYPES

Many readers are aware, of course, that CRT's of 1-inch screen diameter are not new, as the 913, having a nominal screen diameter of this order, has been available since before the war—but always at a price. The English CRT referred to has a slightly greater effective screen area than the 913, apart from the added feature of self-focusing. These tubes are new and are not ex-disposals. Furthermore, they are being made available complete with socket, a lock-in type (European B8G).

The tube has an overall length of 3.94 inches, a maximum diameter of 1.18 inches and presents a green pattern on its short persistence Willemite screen. It has a heater rating of 6.3 colts at .6 amperes and operates with a single anode voltage of from 500 to 800 volts.

The deflection sensitivity is such that a single voltage amplifying stage is adequate for each pair of deflecting plates.

For the range of anode operating voltage mentioned above, the construction of the electron gun produces automatic electrostatic focusing. This eliminates one control—a good thing on a small unit. As a matter of fact, the "intensity" control could also be eliminated by biasing the tube grid with a .1 megohm resistor in the cathode lead, but for general use, we prefer a control on the intensity of the pattern.

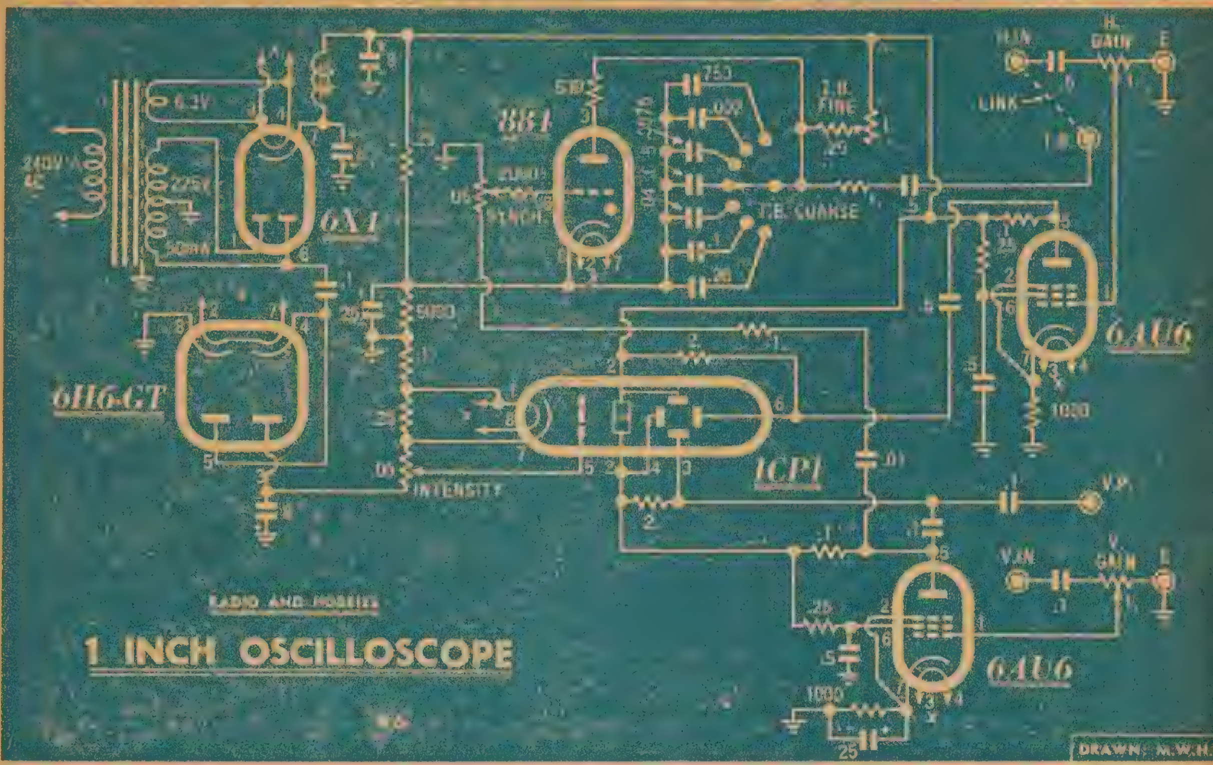
Our preliminary test set-up with this tube eventually ended up as the finished job you see in the photographs. It is built in our standard instrument case, measuring 9 1-8in. by 6 5-8in. by 5½in. deep. It actually takes less space on the bench than the standard multimeter, and is just as easy to use in its own sphere of operation.

AMPLE RANGE

The built-in time base oscillator covers from about 20 cycles to just over 10 Kc in seven steps, and the deflection plate amplifiers have sufficient frequency response to cover most general applications.

The number of controls and ter-

CIRCUIT OFFERS FULL AUDIO TEST FACILITIES



This comparatively simple circuit is in tune with the requirements of the unit. To keep the design on a modest level, we have omitted all elaborations found in larger oscilloscopes. Viewing the circuit from the right-hand side will show the termin in the same relative position as on the front panel.

minals are down to a minimum. As a matter of fact, the whole design has been trimmed—simplicity and cheapness being the keynote.

From the outset we concentrated on developing the design around a standard readily available power transformer. We managed to do this using the 225 volts a side 50 mA transformer. It has but one 6.3 volt heater winding, but by careful distribution of voltages around the circuitry we managed to get away with this restriction, while still remaining within the rated potential difference between heater and cathode of all valves and CRT, with the exception of the 6H6GT.

SAFE IN PRACTICE

We don't think that you will be unduly worried about the 6H6GT for a number of reasons. Firstly, they have been successfully used in similar circumstances, that is beyond their potential ratings, in many applications both in Australia and overseas, though not necessarily with the manufacturers' blessing. One could hardly expect that.

Secondly, it is a tube which is most likely to be on hand, or, for that matter, can be purchased for a few shillings from disposals sources.

The power transformer and the 6X4 is arranged in the usual fashion and, due to the comparatively low current drain of the deflection plate amplifiers and the time base valve, the output voltage from the choke-capacitor filter is of the order of 300 volts.

The 6H6GT is wired in a voltage-doubling circuit fed from one half of the 225 volt secondary winding. For the value of .1 mfd coupling between the winding and one half of the 6H6GT, the resulting output voltage for a drain of about 1 mA is around the 400 volt mark.

This voltage is negative with respect to chassis and when added to the positive voltage available from the 6X4 rectifier, brings the gun voltage for the CR tube to a total of 700 volts.

The negative output voltage from the 6H6GT is half-wave rectified and requires a reasonable amount of fil tering to avoid "intensity modula tion" of the electron beam of th CRT. About 1 mfd would be satis factory, but as this value is not nor mally available in one unit, we used an 8 mfd electrolytic as its voltage rating is more than adequate fo the job.

The "bleed" circuit of the two series-connected supplies has a tota of .65 megohm. The "intensity" con trol is the first resistor from the

PARTS LIST

1 chassis 8¾in by 5¼in by 2¼in.
1 standard instrument case 9in by 6½in by 5½in (inside dimen.) complete with front panel and handle.
1 power transformer 225 V a side at 50 mA, 6.3 V at 2 A.
1 filter choke.
1 1-pole, 12-position switch.
3 7-pin miniature sockets (2 with shields), 2 octal sockets.

VALVES

1 6X4, 1 6H6GT, 2 6AU6, 1 884 (gas thyratron), 1 1in cathode ray tube (1CP1 or similar complete with socket).

RESISTORS

2 2 meg. ½w., 3 1 meg. potentiometers, 2 1 meg. ½w., 5 .25 meg. 1w., 3 .1 meg. 1w., 2 .05 meg. potentiometers, 1 5000 ohm 1w., 1 2000 ohm ½w. 2 1000 ohm ½w., 1 500 ohm ½w.

CAPACITORS

2 25 mfd 40PV electrolytics, 3 8 mfd 525PV electrolytics, 5 .5 mfd 350 VW, 1 .25 mfd, 5 .1 mfd 350VW, 2 .02 mfd, 2 .01 mfd, 2 .005 mfd, 1 .0025 mfd, 1 .002 mfd, 1 500pf, 1 250pf.

SUNDRIES

6 terminals (4 red, 2 black), 1 8-tag, 1 7-tag and 1 3-tag mounting strip, 1 1in. threaded mounting pillar, 5 ⅜in i.d. rubber grommets, 6 pointer knobs, scrap aluminium for CRT mounting bracket and CRT screen hood, length of heavy water piping (1⅛in inside diam. or larger) for CRT magnetic shield, power flex and 3-pin flat plug, spaghetti sleeving, hook-up wire, solder, solder lugs, nuts, bolts.

THE WARBURTON FRANKI PAGE

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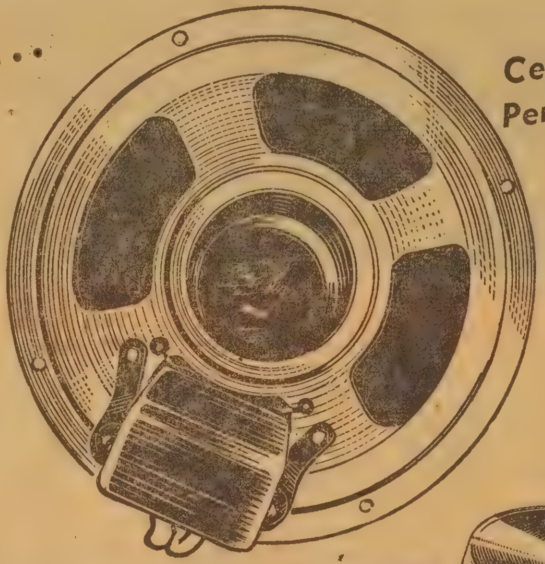

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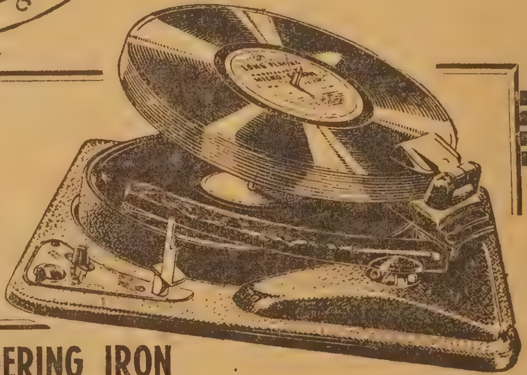

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negative end, its purpose being to tap off the required amount of grid cathode bias for the CRT so that the brilliance of the pattern on the screen can be adjusted.

From the CRT cathode to earth the resistance in circuit is broken into two parts so that the heater circuit of all valves can be placed at the appropriate level for the reason mentioned earlier. The remaining resistor is the .25 megohm across the 300 volt supply. The drain on the supply feeding the amplifiers and time base is under 10 mA. At this low drain the primary winding of a speaker transformer would do for a filter choke.

The type 913 1-inch CRT could be fitted into this circuit without any trouble. The only modification would be the provision of a "focus" control. This could be arranged by replacing the .25 megohm fixed resistor in the negative supply with a potentiometer of the same value and taking the moving arm to the second or focusing anode.

THYRATRON BIAS

The 5000 ohm resistor in the earth end of the positive supply bleed provides a small positive voltage for the cathode of 884 thyratron. This effectively biases the grid to set the level of plate voltage at which the tube ionises. The net result of this bias is to control the output voltage and linearity from the time base circuit.

The electron beam of the CRT which we used was sufficiently close to being centred on the screen as not to want any correction. Consequently, we omitted the usual "shift" controls for the deflection plates on the assumption that they were a refinement rather than a necessity in a unit such as this.

If you find that you simply must centre the beam, here is a simple way to do it. In between the "top" .25 meg bleed resistor and the positive HT place two potentiometers in series, each wired as a variable resistor. Take the final anode of the CRT to their junction (instead of the full positive HT), one deflector plate isolating resistor (2 meg) to the junction of the .25 meg and the "lower" pot and the other deflector plate resistor to the positive HT.

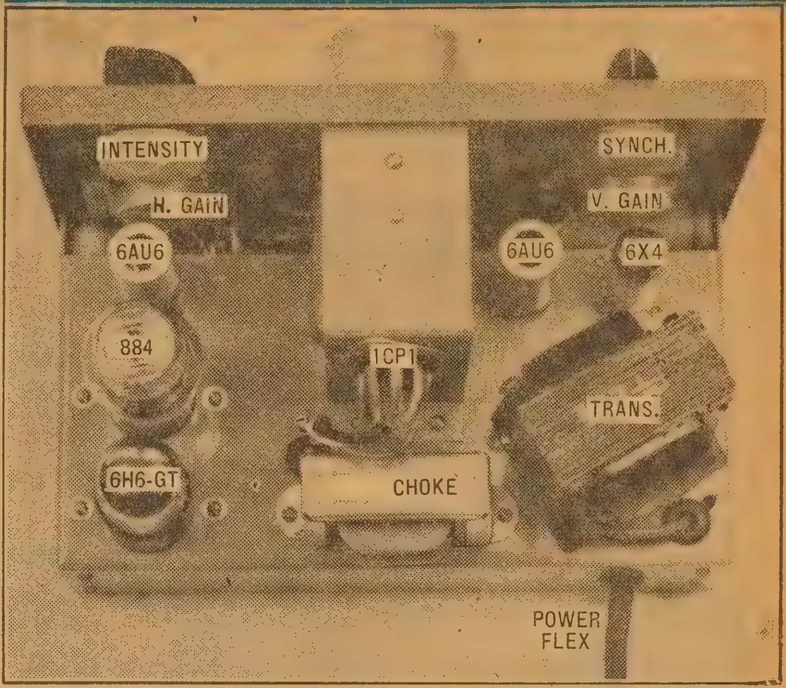
Adjust the pots until the beam is centred and replace them with resistors of approximately the same value as that to which the pots were adjusted. You may have to reverse the deflector plate resistor connections to the pots.

There was little that could be done to trim the time base circuit of "unnecessary" components. Although we have shown a 12-position switch, of which seven positions are used, to select appropriate values of time base capacitor to cover the frequency range, there is no reason why this could not be modified to suit a switch which you may have on hand.

For instance, a 2-pole 5-position switch is a fairly common type. Using one pole, you could select values with the aid of the table given on page 33 to cover, in five steps, the ranges in which you feel you would be most interested. Some capacitor values have to be made up by paralleling two standard values.

Bear in mind that one usually inspects an oscilloscope pattern consisting of more than one cycle. Three to five cycles is a usual pattern. Therefore, to view a 15 kc waveform, a time base frequency of only 5 kc would present 3 cycles, while a 3 kc time base frequency would present 5 cycles.

REAR VIEW OF OSCILLOSCOPE

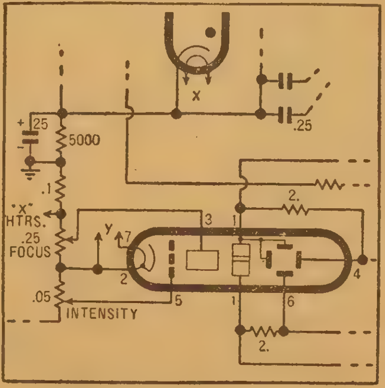


This view gives you the position of the major components coded for easy identification. The pipe shield for the CRT is secured to the CRT mounting bracket. The power transformer has been orientated for minimum magnetic deflection of the CRT beam.

Note that the coupling capacitors from the time base to the horizontal amplifier are .5 mfd. These large values are necessary to avoid impairing the linearity of range A.

The time base output is linked across to the amplifier input on the front panel. This arrangement permits the horizontal amplifier to feed from an external source as in transmitter modulation checking.

We omitted the usual "black-out" connection between the thyratron anode and the CRT grid. It saves a couple of components and avoids variation of beam intensity when the time base circuit is changed from a low to a high frequency. The presence on a pattern of the time base "flyback" trace is not disturbing, and in a modest design such as this it doesn't matter very much.



Here is the modification to provide a focusing voltage for a 913 CRT. The heater should be fed from a separate winding or filament transformer. One side of the "X" heater circuit should connect to the EHT bleed.

For the time base thyratron we used the 884 instead of the EN31 because of its lower heater rating of .6 ampere. This brings the total drain on the 2 ampere heater winding of the power transformer to 2.7 amperes.

The EN31 has higher all-round ratings than the 884. It could probably be used even though its 1.3 ampere heater rating would raise the total drain on the heater winding to 3.4 amperes. The normal loaded primary current of the transformer would not be exceeded because the heater winding overload is counterbalanced by the rather light loading on the HT secondary winding.

LOADING CHECK

We gave a typical transformer a running check under loading similar to what would be imposed with an EN31 in the time base and found that there was no undue heat rise and the heater winding voltage was over 6 volts.

Conventional pentode voltage amplifiers are used to "drive" the deflector plates. The cathode resistor of the horizontal amplifier is left unbypassed so that the resulting degenerative feedback would improve the frequency response for handling the time base sawtooth waveform. Even with the cathode unbypassed, there is more than ample gain.

The screen of both amplifiers are bypassed with a .5 mfd to maintain a reasonable low frequency response. For this same reason, but with

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5 Valve Karset (R & H April 1952)

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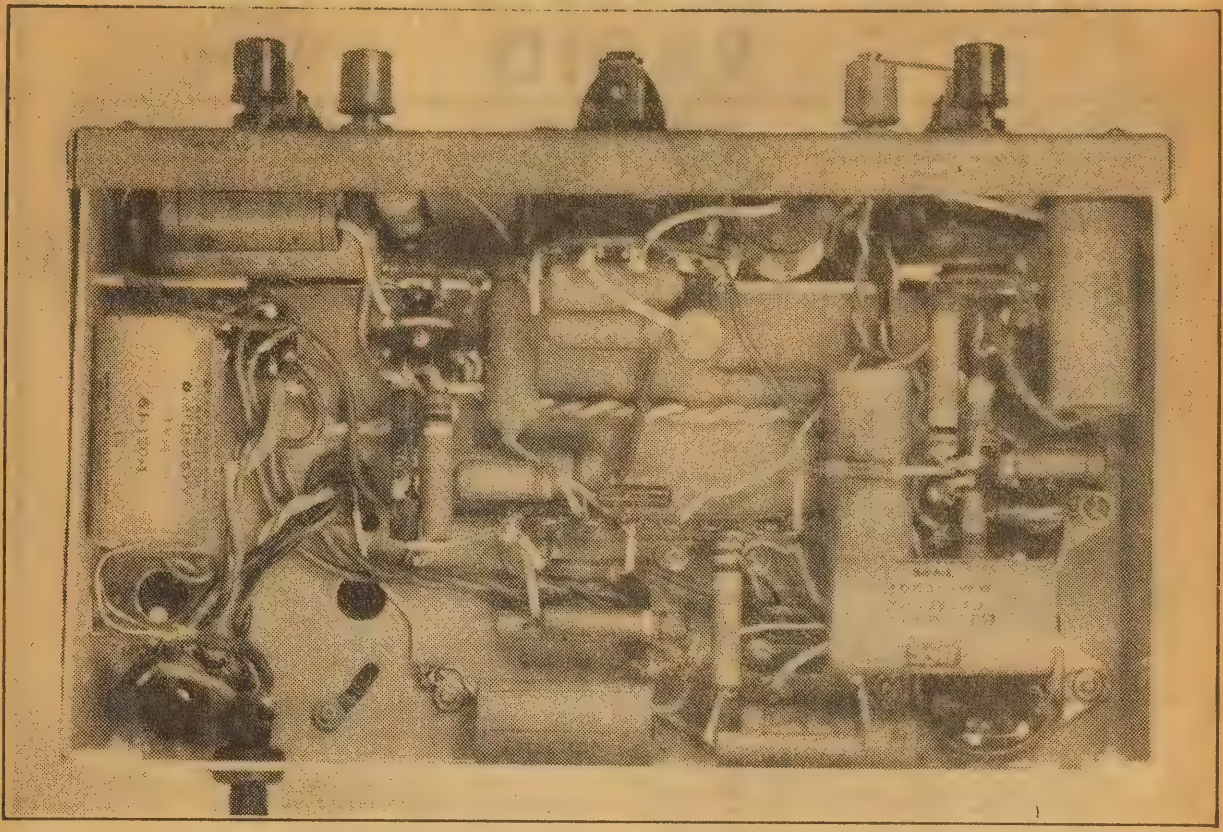

Here is an underneath view showing a logical layout of the minor components. Try to follow this arrangement to avoid possible interaction between the time base and other circuits. Note how the time base capacitors are grouped around the switch, the time base coarse control. Other capacitors associated with the amplifiers are tucked against the front panel and the sides of the chassis.

greater emphasis, a .5 mfd is used for coupling from the horizontal amplifier to its deflector plate.

The frequency response requirements of the vertical amplifier are not as stringent as for the horizontal (time base) amplifier, and consequently .1 mfd coupling capacitor value for both input and output is quite adequate. For the same reason the cathode resistor is bypassed in the normal fashion to obtain the benefit of the full gain capabilities of the stage.

VERT. PLATE TERMINAL

The vertical deflector plate is also brought out to a terminal on the front panel for direct connection to the plate during, say, transmitter modulation checking. The extra .1 mfd coupling capacitor is required to keep the HT from the terminal. In effect, this places the output of the vertical amplifier at the same terminal, an unintentional facility which could be useful at some time or other in some separate application on the bench.

The plate of the vertical amplifier is also fed to the time base synchronising control through a 1 megohm resistor to prevent undue shunting of the amplifier plate load impedance. A small portion of the amplifier output is tapped off by the "synch" control and, being fed to the control grid of the 884 thyratron, locks the time base to the signal being investigated so that a stationary pattern is obtained.

The time base should still be adjusted close to the required sweep frequency and just sufficient "synch" voltage employed to satisfactorily lock the pattern. Over-synchronisation will distort the pattern and reduce the time base output.

The photographs show the general layout of the major and minor components. Note that the power transformer is orientated so that the effect of its magnetic field upon the electron beam is at a minimum.

Time Base Frequencies

RANGE	FREQ.
A	23-55 cycles
B	55-145 ,,
C	140-335 ,,
D	360-800 ,,
E	790-2000 ,,
F	2-4.7 Kc
G	4.4-10.3 ,,

If you make up your own chassis, arrange the mounting holes for the transformer so that it can be rotated over an arc of plus and minus 10 to 15 degrees. When the unit is finished, position the transformer for minimum deflection of the beam or pattern and secure it in place.

What magnetic deflection remains can be minimised by fitting a shield around the CRT. While mu-metal, or similar material, is excellent for magnetic shielding of a CRT, a reasonably effective substitute is a length of heavy-gauge water pipe. We used a heavy pipe union. By "heavy", we mean slightly under ¼in thickness.

The shield should enshroud the full envelope of the CRT. If the inside diameter of the pipe is at least 1½in it can be slung under the horizontal portion of the CRT socket bracket without coming in contact with the CRT glass envelope.

In mounting the CRT socket on to its bracket, use oversize holes so that it can be positioned in relation to the panel opening and rotated a couple of degrees either way to place the trace horizontal.

CRT HOOD

The matter of a hood over the CRT screen to shield it from incident light is best left to the individual. We cut up an old-type aluminium valve shield for the purpose. There is something to recommend a complete circular hood, although it will depend somewhat on the lighting conditions under which the unit will be used.

A well-built instrument deserves a neat lettered front panel and, besides, it avoids having to take a guess at which control is which. It is obvious that this would have to be done before the panel is fitted.

An engraved panel, with white-

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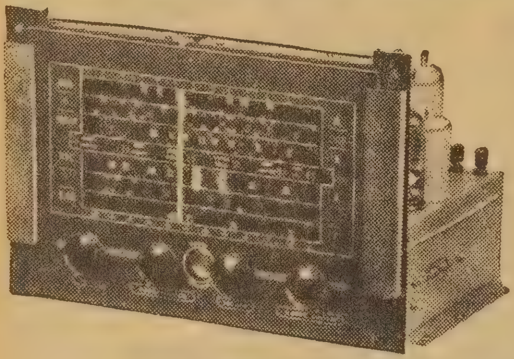

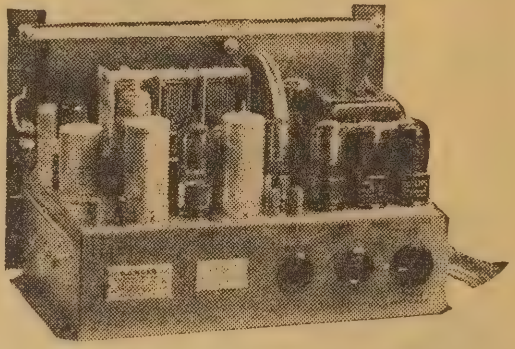

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colored filling, is very pleasing to the eye and is a fairly cheap method. Hand lettering in black or white can be quite acceptable, depending upon how well you can print. Small mechanical devices to aid in hand printing are readily available and do a good job.

Hand lettering requires a fairly smooth surface, however, and you will notice that the brocade finish on the front panel of the standard instrument case doesn't lend itself to this process. You may be able to smooth off a small rectangular area near each control and terminal to take the required lettering, after which a coating of clear lacquer will seal it off.

It is a good plan to mount all of the major components, including the panel controls, before commencing the wiring. Cut the shafts of the controls to the appropriate length before finally securing them into position. We used a number of spacing washers behind the controls to prevent the threaded mounting sleeve from protruding too far from the panel. This permits the knobs to fit close to the panel, giving a neater appearance.

SOCKET ORIENTATION

A particular orientation of the valve sockets makes for easier wiring and, as a guide, this is the way we have them: the horizontal amplifier with the gap between pins 1 and 7 toward the adjacent corner, the vertical amplifier with the gap toward its input terminals, the 6X4 with the gap toward the adjacent corner, the 884 with the keyway toward the chassis rear and the 6H6GT with the keyway toward the front panel.

The capacitors for the time base coarse control are grouped around the switch. If you use the smaller size tubular capacitors you will not have any difficulty here. As a matter of fact, apart from the 8 mfd electrolytics, we have used the small size tubular throughout.

You will find that this is particularly important with the .5 mfd capacitors. There is not a great deal of space available unless one were to resort to stacking components in layers, and this would not be appreciated during any future servicing of the instrument. By laying most of the larger-sized capacitors against the sides of the chassis and front panel we have managed to keep the centre portion of the chassis free for general wiring.

TIE POINTS

Tag-mounting strips are used for holding wiring junctions and mounting most of the small components.

Similarly, pin 4 of the 884 socket is used as a high tension tie-point to feed the plate and screen of the horizontal amplifier. Pin 6 of this socket carries the junction of the 2000 ohm and the moving arm of the "synch" control. Pin 1 of this socket carries the junction of the 500 ohm, the 1 megohm and the switch in the time base circuitry.

On this same trend, a spare lug on the time base switch is used to carry the common side of each time base capacitor.

Some resistors need to be of the 1-watt size, while in other cases, the ½-watt size is adequate and, besides, takes up less space. The appropriate rating is given to each resistor in the parts list.

For the connection to the power mains, we suggest that you use 3-core power flex, taking the green-colored wire as the earth connection between the chassis and the earth pin of the power mains plug.

One final point. Avoid too much intensity on the CRT screen, particularly with a stationary pattern o just the time base line, as it is liabl to leave a permanent mark, called "burn." This is very important with just the undeflected spot on th screen.

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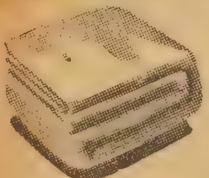

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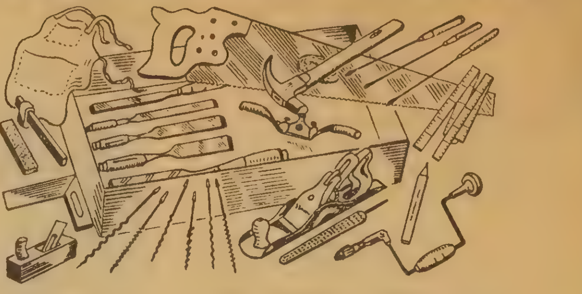

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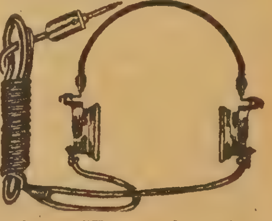

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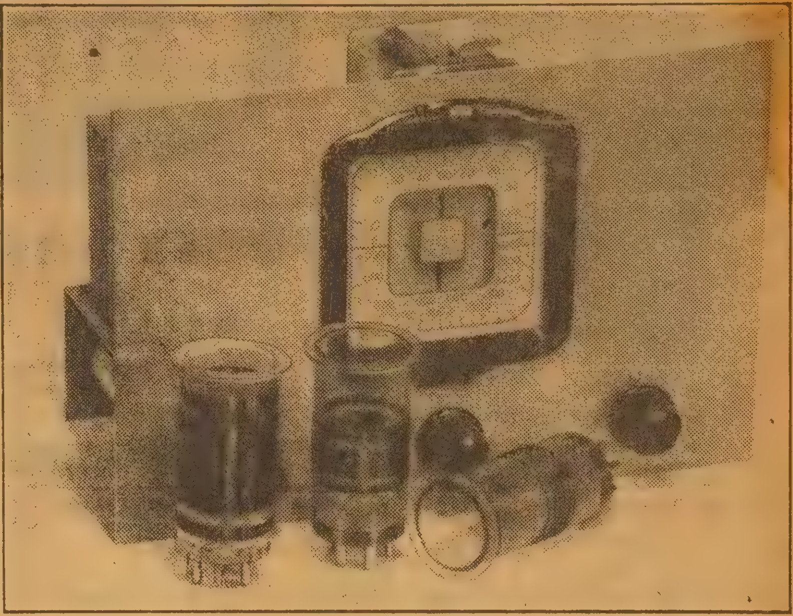
MORE ABOUT 1953 "LITTLE JIM"

As intimated last month, we have prepared a wiring diagram and additional coil data for the 1953 "Little Jim". The information should be valuable to beginners who may have decided to build up this fine little set.



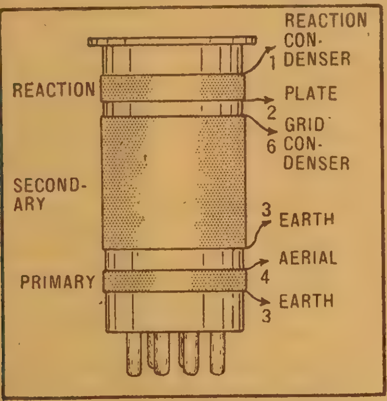
"Little Jim" for 1953, together with the three hand-wound coils necessary to cover the broadcast and short-wave bands. A full descriptive article of this set appeared in our last issue.

THE wiring diagram which appears on the next page shows the entire wiring in pictorial form. It will materially assist those who find difficulty in reading the ordinary schematic circuits.

The components for the most part are depicted close to their proper positions, although some concession has to be made to allow all the parts and the wires to be shown clearly.

Beginners could profitably spend time tracing the connections as depicted in the schematic and the pictorial diagrams. Once you get the idea of reading schematic circuits you will see how much more clearly they depict the operation of a receiver.

The photograph above shows the set, together with the three new coils which we wound up during the month. Full data and the order of the connections to the windings appears on this page.



This diagram shows the pin numbers and order in which connections are made to the windings. The data below assumes a former diameter of 1¼ inches.

The detail drawing above resembles the broadcast coil most closely in appearance but the essential information it contains applies to all three coils.

All windings should be put on in the same direction and the diagram shows the order of the connections. Thus the bottom of the primary winding should go to earth, the top to aerial. Bottom of the grid winding should likewise go to earth, top to the grid condenser. Bottom of the reaction winding goes to plate, top to the reaction condenser.

The numbers indicate the pin on a 6-pin former, as used in the original set, but the arrangement can be varied if you have any special reason for so doing. The important point is to see that the windings ultimately connect to the appropriate points in the circuit, as indicated, through leads which should be no longer than necessary.

Unfortunately, due to a last-minute rush, we failed to pick up a couple of errors which crept into the tentative coil specifications given last month. Thus we suggested 24 and 32 gauge wire for the grid and reaction windings of the broadcast coil, whereas the correct gauges should respectively have been 32 and 40. It is fairly obvious that the number of turns specified simply would not fit on to the former with the larger gauges.

The original coil used the proper wire, but in telling the story we got our figures mixed.

The new data as set out in the tabl should be very close to the mark anc require a minimum of "pruning" to achieve optimum results. As we explained in the last issue, the very best results can be obtained only from a small set after the aerial coupling has been adjusted to suit your location and set-up and after the reaction circuit has been made to operat smoothly.

More of this anon.

BROADCAST COIL

For the broadcast coil we sugges 32 SWG enamel or 30 B & S. Wire slightly finer or thicker than thi will make the winding slightly shorte or longer than the original but wil not greatly affect the performance You will notice also that we hav

COIL WINDING DATA

BAND	PRIMARY	SECONDARY	REACTION
Broadcast Band	15 t. 32 SWG g. enam. spaced 3-16in from earthed end of secondary.	100 t. 32 SWG g. close wound.	40 t. 40 SWG g. enam. spaced ⅛in from grid end of secondary.
33 to 140 metres. 9 to 2.3 mcs.	7 t. 32 SWG g. enam, spaced ⅛in from earthed end of secondary.	16 t. 24 B & S g. enam. close wound.	10 t. 32 SWG g. enam. spaced ⅛in from grid end of secondary.
12 to 43 metres 25 to 7 mcs.	1 t. 32 B & S g. enam. interwound 1 t. from earthed end of secondary.	5 t. 24 B & S g. enam. spaced to occupy ½in.	5 t. 32 B & S g. enam. spaced ⅛in from grid end of secondary

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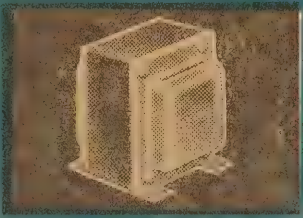

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TYPE	PRIM-ARY	mA	H.T. VOLTS	FILAMENT RATINGS			MOUNTING	RETAIL PRICE
U30/150	230/240	30	150/150		6.3v/1.7a		Midget Upright	29/7
U or F40/150	"	40	150/150		6.3v/2a		Upright or Flat	39/9
U or F40/285	"	40	285/285	6.3v/2a		5v/2a	Upright or Flat	44/-
U or F40/325	"	40	325/325	"		"	Upright or Flat	45/6
U or F50/225	"	50	225/225		6.3v/2a		Upright or Flat	44/9
U or F60/285	"	60	285/285	6.3v/2a		5v/2a	Upright or Flat	53/2
U or F60/325	"	60	325/325	"		"	Upright or Flat	54/1
U or F60/385	"	60	385/385	"		"	Upright or Flat	58/3
U or F80/285	"	80	285/285	6.3v/2a	6.3v/2a	5v/2a	Upright or Flat	60/10
U or F80/325	"	80	325/325	"	"	"	Upright or Flat	62/4
U or F80/385	"	80	385/385	"	"	"	Upright or Flat	65/5
U or F100/285	"	100	285/285	6.3vct/2a	6.3v/2a	5v/2a	Upright or Flat	67/6
U or F100/325	"	100	325/325	"	"	"	Upright or Flat	69/-
U or F100/385	"	100	385/385	6.3vct/2.5a	6.3v/2a	5v/2a	Upright or Flat	76/5
U or F125/285	"	125	285/285	6.3vct/2a	6.3v/2a	5v/2a	Upright or Flat	85/4
U or F125/325	"	125	325/325	"	"	"	Upright or Flat	86/11
U or F125/385	"	125	385/385	6.3vct/2a	6.3v/2.5a	5v/3a	Upright or Flat	95/9
U or F150/285	"	150	285/285	"	"	"	Upright or Flat	89/8
U or F150/325	"	150	325/325	"	"	"	Upright or Flat	96/7
U or F150/385	"	150	385/385	"	"	"	Upright or Flat	111/11
*T80/250	"	80	250/250	6.3v/2a		5v/2a	Upright	60/-

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TYPE	INDUCTANCE IN HENRIES	mA	D.C. RESISTANCE	RETAIL PRICE
A.12/50	12	50	560	11/6
B.14/60	14	60	520	13/9
C.20/60	20	60	500	25/5
D.30/60	30	60	600	45/-
C.15/80	15	80	430	42/11
E.20/80	20	80	300	45/-
E.30/80	30	80	380	48/5
F.15/100	15	100	300	45/-
F.15/125	15	125	250	59/-
F.15/150	15	150	200	67/-

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dropped the total number of turns to 100, thereby pushing the coverage beyond the high frequency rather than beyond the low frequency end of the broadcast band.

The primary winding can be wound with the same gauge and the optimum number of turns will depend on your locality and the length of your aerial. Long aerials and localities close to the stations generally dictate a reduced number of turns on the primary.

We suggest that you start with the full 15 turns on the primary then, if the stations spread too much or are louder than necessary with the reaction set critically, try reducing the primary turns until the better balance is struck.

SERIES CONDENSER

Alternatively, you can reduce the effective coupling by inserting a small value of condenser—25 to 100 pf—in series with the aerial connections for broadcast reception only.

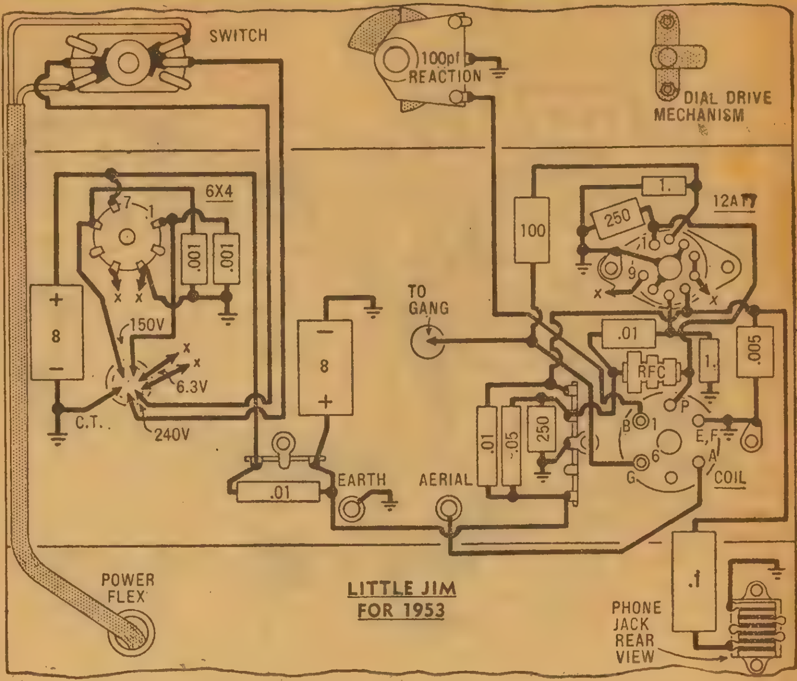
The reaction winding is wound with a much finer wire, mainly to avoid having it run off the top of the former. The gauge is otherwise not critical.

It should operate quite well with the number of turns specified, though you may find that you can get slightly smoother reaction by reducing the number slightly. A lot depends on the individual detector valve, the type of RF choke and the precise operating voltage.

Coming to the short-wave coils, we have deliberately varied the number of turns slightly to spread the total

(Continued on page 103)

WIRING DIAGRAM FOR 1953 "LITTLE JIM"



This wiring diagram depicts all the wiring and the minor components beneath the chassis—most of them in approximately their original positions. Phone jacks vary in their terminal arrangement and may not correspond exactly with the diagram. The 0.1 mfd. condenser should be wired to the blade which makes contact with the tip of the phone plug. The shaft portion of the plug should be earthed.

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Let's Buy An Argument

The subject of output loads and loudspeaker matching is one which crops up quite regularly in our correspondence, the letters revealing attitudes ranging from a complete ignorance of the subject to a near-obsession for accuracy. Let's look at the facts and see where we get to.

by W. N. Williams

O begin with a statement of the obvious, all power output valves e given ratings which include class operation, plate, screen and grid lts, power output and "optimum ad." There are other things on e data sheets, of course, but I am t immediately concerned with em.

The first point to note is that the ecommended load isn't some fixed uantity for each particular valve. may vary within wide limits acrding to the class of operation, the plied potentials and so on. Even change from fixed to cathode bias ay dictate a change in optimum ad in certain cases.

IT OR MISS

How inconclusive, therefore, was e one-time practice of branding (or ecifying) output transformers with valve type number like "6L6" or -P 2A3." You could make an telligent guess at the intended imedance, but you could be quite rong.

Fortunately, most folk have learn the lesson and begun to exchange e required information in terms of ms. Manufacturers supply transformers branded that way, and budding designers are learning to give due consideration to the published data.

However, be that as it may, amplifier enthusiasts still have plenty of other wrong ideas to go on with, as the letters show.

The most "popular" one is the failure to appreciate that the output transformer does not itself provide the true load for the output valve. It is merely a device which "transforms" the voice coil impedance to a much higher and "optimum" apparent value.

As a result, the primary winding can only present the specified impedance when the secondary is coupled to a voice coil (or other load) having the intended value. Thus, a 10,000 to 15-ohm transformer would present a load of only 1300 ohms if inadvertently connected to a 2-ohm voice coil.

We could continue on this "wrong ideas" strain, but we'll keep it for another day. Let's say we agree just now that valves are credited with optimum load figures for various conditions, and that the said loads are allegedly obtained by using a suitable output transformer.

But do the optimum load figures really matter? That's the point I want to get around to. Is the business of loud-speaker matching important?

SHEER HERESY!

Let me whisper it quietly. . . . I'm not sure whether to answer yes or no! I'll tell you why.

In the days when I was primarily concerned with valve curves and the like, I did my share of ascertaining optimum loads by both graphical and practical methods. I know from that experience and from subsequent observation that the published data is generally as close to the mark as it can be for a mass-produced article.

If you set up an output stage with precisely controlled voltages and feed the plate through a high quality choke, shunted with an adjustable resistor, it is possible to plot output power against resistance for some predetermined distortion limit.

You will generally find that the output curve will peak broadly in the region predicted by the published "optimum load" figure.

In other words, on an instrument test optimum load does look like being fairly important.

BUT LOUDSPEAKERS . . .

It still looks important, too, when working with modulators for transmitters, where the load and impedance values can be checked with a fair degree of precision.

But loudspeakers are in another class altogether.

How, for example, would you design a transformer to match a 6V6 under 250-volt class A conditions to a 2-ohm voice coil?

On the surface it's straightforward enough.

The impedance ratio is 5000:2, equals 2500:1. The turns ratio is equal to the square root of this, or 50:1.

The transformer is duly wound up

with the requisite number of turns on primary and secondary, enough iron to avoid saturation, enough wire to give adequate inductance, a minimum of resistance, and so on. Inherent losses can be anticipated and allowed for to preserve the optimum effective ratio under load.

The transformer can then be duly checked with a 2-ohm resistance across the secondary and everything shown to be just so.

Now we substitute the voice coil. At, say, 400 ohms everything is "apple pie"—5000 ohms of resistance reflected back to the 6V6 plate circuit.

HIGHER FREQUENCIES

But what about 1000 cps where the voice coil is inductively reactive and a good 30 or 40 pc high in its "resistance". What is worse, the figure will continue rising with frequency to five or six times its nominal value at 400 cps.

At the bass end much the same is true, except that the impedance depends almost entirely on the baffle.

I wonder how many enthusiasts have accepted or rejected a baffle because it upsets the loading on their output valve. (As the children say . . . "It does so, too, but".)

In other words, I don't see how any designer can work out "exact" specications for a loudspeaker matching transformer and keep a straight face while so doing. How can anyone keep a straight face with their tongue in one cheek?

If what I say is true—and it might be very difficult to disprove—there is no such thing as an accurate loudspeaker matching transformer!

There is no such thing as an accurate match, either!

In an average case the "mismatch" may easily run to several hundred per cent.

Well, then, what justification can there possibly be for worrying about a 50 pc mismatch in a particular loudspeaker-transformer combination?

ASK YOURSELF?

Would you be happy about using a 7000 ohm load with a 6V6 or a 5000 ohm load with a 6F6?

Or would you tolerate a 10,000 ohm transformer on the output of two 6A3s?

Oh, dear, no . . . that's a 50 pc error . . . a 100 pc error! We must get the right transformer, even if it does cost us another fiver!

And yet you don't squirm a bit about the five-to-one variation in the voice coil impedance.

By the time one further adds remarks about the non-critical nature of the human ear and the ability of negative feedback to mask changes in gain we almost convince ourselves that loudspeaker matching doesn't matter at all.

Almost, but not quite!

If you have on hand a universal test loudspeaker—the type servicemen often use—it is possible to make a very simple test. Listen to a typical signal and rotate the "load" switch, noting the effect on the reproduction.

You will find it hard to pick any audible difference between adjacent positions but you can pick the difference between the optimum and extreme settings. It is particularly true of little battery sets which

A READER REPLIES TO "J. R."

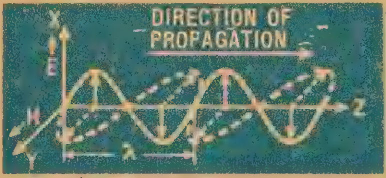
In reply to your letter published in the April issue, I would like to give you some idea of the present day thoughts on Electromagnetic radiation—for Electromagnetic radiation is what you are endeavoring to explain. By EM radiation is meant all types of radiation in the EM spectrum, from low frequency radio waves, up through the high frequencies, infra red (or heat), visible light, ultra violet, x-rays, gamma and cosmic rays. All these rays are Electromagnetic radiations, the only difference being in the wavelenght (or frequency). In a vacuum they will all travel with the velocity of light.

Your theory, and the stone in the pond theory, was held by classical physicists up till the turn of this century. In 1905, Einstein (that man again!), in attempting to explain the photoelectric effect (ie, the emission of electrons from metal by the action of light), took the view that radiation is propagated in localised bundles; and does not spread out in ever growing spheres (as proposed by you).

Earlier, Maxwell had evolved a fairly complete, but rather complex, theory of radiation. It was originally a theory, but experiment has proved many of the theoretical results.

Present day theory combines the views of Maxwell and Einstein in the following way:-

Electromagetic radiation is considered to consist of two components—an electric field usually denoted by E, oscillating in one direction; and a magnetic field, H, oscillating in a direction at right angles to E. The two fields oscillate at right angles to the direction of propagation (see diagram). That is, x, y and z are mutually perpendicular. The electric field E is in the x direction, the magnetic field H is in the y direction, and the direction of propagation is along the z axis. This type of radiation is known as "Plane-polarised", and is characteristic of that emitted from a radio aerial.



In more complicated waves, the electric field has a component in the y direction also, and the magnetic field has a component in the x direction. Note that this theory can be applied to all types of radiation—for example light. Light is one of the more complicated forms of EM radiation, but it can be plane-polarised, as is well known, by the use of say "polarised" glass, or a Nicol prism. Note also that this explanation is for radiation from a point.

This is Maxwell's contribution—Einstein's part is that the emission of radiation is not continuous, but occurs intermittently, in bundles.

Now Max Planck enters the scene—earlier, about 1900, in an endeavor to explain the radiation from a hot body, Planck postulated the emission of radiation in bundles — he called them "quanta". Einstein applied this idea to all EM radiations, in that all radiations occur intermittently, in quanta, each quanta having energy or hV; where h is Planck's constant, = 6.6 x 10 to the power —27 erg secs., and V = frequency of the radiation.

FULL EXPLANATION

By building up a theory on these basic ideas, it is possible to explain all observed effects of EM radiations. I am afraid I cannot provide a simpler or clearer explanation in the space available. To explain further really requires the use of mathematics, and if you are a good "book learner", it might pay you to get hold of some advanced books on the subject.

Terman, F. E.—Radio Engineering;

Harnwell, G. P.—Principles of Electricity and Magnetism;

Frank, N. H.—Introduction to Electricity and Optics; all published by McGraw Hill Book Company.

As regards your remarks on VHF and TV, there is no reason why greater power should not be employed in UHF (from a radiation point of view). Powers in the region of 50 kilowatts and more are being used at 50-100 Mc/s.; and in higher frequencies the power is rapidly being raised.

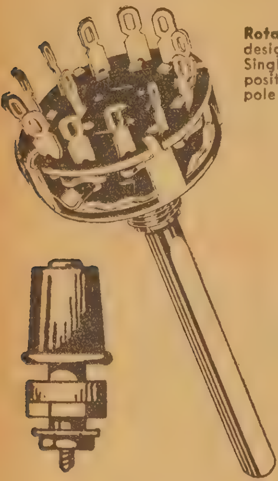
The reason for short-range is the high coefficients of absorption of the atmosphere and natural obstacles (mountains, buildings; &c) for radiations of these frequencies. (Just think how heat is absorbed by wood or earth, and it will give you some idea of the problem.)

As for television (on low frequencies—a glance at the first few chapters of any book on TV will show that the signal frequency is controlled mainly by the number of lines, and the picture repetition rate. These give frequencies of the order of 2½ Mc/s for 405 line transmission, and 6 Mc/s for 625 line transmission. From modulation theory (see a suitable text book — say Terman, the carrier wave must be at least twice the signal frequency. Thus, for 625 line TV we have a minimum carrier frequency of 12 Mc/s. In practice, it is better to have a much greater difference between carrier and modulation frequency, hence the need for VHF for TV.

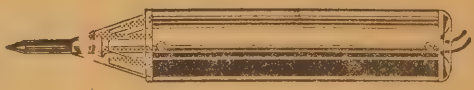
If you desire any further information, I would be only too glad to assist you in any way I can.

Yours faithfully,
MURDOCH FINLAY

JABEL *Fine* RADIO COMPONENTS

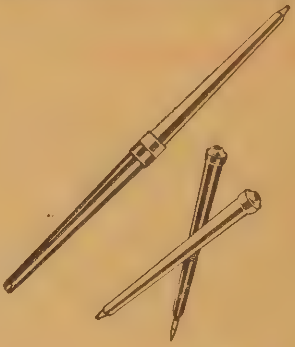


Rotary Wafer Switch. A single bank unit of compact design. Diameter only 1¼" (size of a penny), depth ⅞". Single pole type, up to 12 positions; two pole to 6 positions; three pole to 2 and 3 positions; and four pole to 2 and 3 positions.

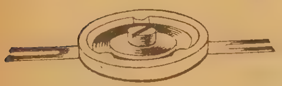


Probe Housing. Chrome-plated brass tube with clear polystyrene mouldings. Internal size, ¾" x 4".

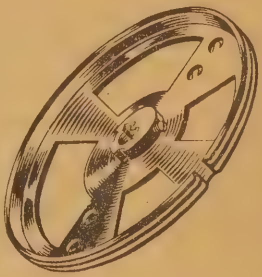
Insulated Spring Terminal. Fully insulated from chassis, nickel-plated brass post, moulded polystyrene body. Made in six brilliant colours—red, black, light and dark blue, green and yellow.



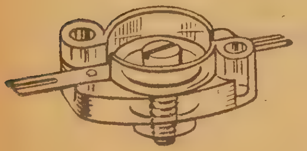
Aligning Tool. A dual-purpose tool with screwdriver tip for standard I.F. transformers. Reverse end has recessed slot for miniature I.F's. Nickel-plated brass fittings moulded into polystyrene. **Test Prods.** In red and black polystyrene, plated brass tips, ample lead space.



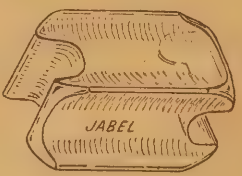
Junior Trimming Condenser. Non-hydroscopic compression moulded base, nickel-plated phosphor bronze plate. Fine thread, giving smooth linear variation from 4 to 60 mmfd. The diameter of sixpence, and ⅛" thick—ideal for gang mounting.



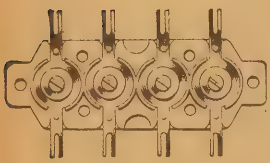
Dial Drum. 5" moulded polystyrene, perfectly flat and true. Non-microphonic. Double track.



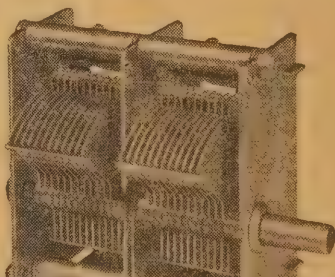
Standard Trimming Condenser. A chassis mounting type in clear moulded polystyrene. Similar characteristics to Junior model.



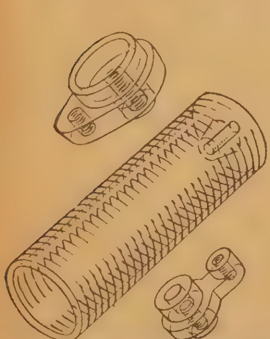
Egg Insulator. Polystyrene moulding—the lightest, strongest and best insulator procurable. Absolutely unbreakable.



Trimming Condenser Blocks. The Standard Trimmer is also available in blocks of four (illustrated on left), three and two units.



"H" Gang Condensers. Single, two and three gang types, supplied with mounting feet. Capacity, 15 to 415 mmfd.



Moulded Polystyrene Coil Former and Coil Mount Bases. ¾" diameter formers, 2" long, grooved to 16 T.P.I. (or plain), one end open, other tapped 5/32" for mounting or core. Larger coil base fits either ¾" or ½" formers and is tapped for core and mounting. Small unit is for ⅜" formers, also tapped as above.

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haven't any power to waste in a mismatched or an inefficient transformer.

Therefore, even though the impedance of the voice coil may vary to an alarming extent with frequency the output valve is sensitive to the order of the matching, if not to the exact figure. On these grounds, alone, therefore, you you can't expect optimum results from a valve requiring a 15,000 ohm load, if you try to use it with one representing only a fraction of the impedance.

The basic reason for this probably is that the voice coil holds its rated impedance reasonably well between say, 150 and 1500 cps, and this range contains most of the essential sound energy for speech and music.

SUMMING UP

When the matching is lost in this basic region, the output-to-distortion ratio suffers and with it goes the performance, as judged by ear.

Having thus sown many seeds of doubt and dissension in your mind, let's make an attempt to be constructive for a change and try to sum up the situation in the traditional manner:

(1) The published figures for "optimum load" are accurate for the most part and can be taken "as read."

(2) The published figures are for an idealised resistive load. Since this cannot be duplicated with a loudspeaker, the actual load, power output and distortion figures will generally not be as good as those published.

(3) Since perfect maching cannot be achieved anyway with a loudspeaker load, it is futile to worry about a small percentage of mismatch, based on the speaker's nominal voice coil impedance.

(4) It is good practice to combine components which provide an exact nominal match but do not worry overmuch if economic considerations oblige you to tolerate a mismatched impedance up to 50 pc too high or too low. The difference will probably not be audible. Beyond that, performance may begin to suffer, particularly if the equipment has to operate near full power.

(5) Overall negative feedback will lower distortion figures and may even render a serious mismatch unimportant at low power levels. However, it cannot correct loss of maximum power output due to incorrect loading.

There, it would appear, the matter will have to rest until someone succeeds in producing a loud-speaker with an impedance value so near constant that we don't need to worry further about it.

I seem to remember a reference, back in the dim past, to some speaker with a near-constant voice coil impedance, but I imagine that it might have been more of a freak than a practical mass-produceable design.

On the surface, it would seem that the matter of voice coil impedance is bound up very closely with that of acoustic efficiency. If a speaker can be so designed and baffled that most of the electrical input can be translated into acoustic work, then the resistive component in the load must surely become far more significant.

But while the efficiency stays down

(Continued on Page 103)

A PROBLEM FOR TAPE FANS

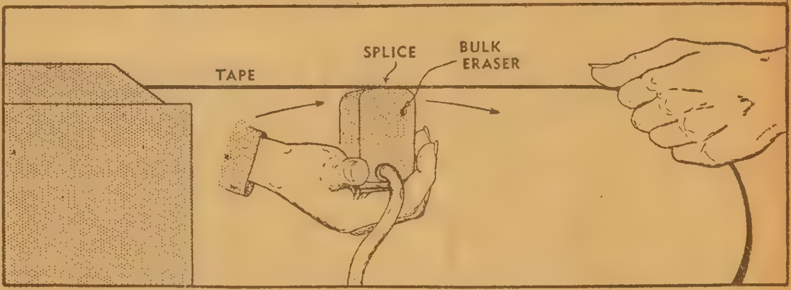
Question: While editing a tape the other day, I found it necessary to splice a speech recording which ended very abruptly on to a musical recording which began in the same manner. The problem was to effect a smooth mating of the two tapes without the necessity for re-recording. I finally managed it but how would you tackle such a problem?

ANSWER: I experimented first with two similar pieces of reject tape to judge the value of four possible methods, as under:

(1) A few inches of blank tape were spliced between the two. This introduced a suitable time delay, but did nothing to relieve the abruptness. Furthermore, the abrupt insertion of a completely silent segment of tape between tapes having some characteristic program background emphasised the presence of a "patch." (Extra splices are a bad thing anyway.)

Method number one was no good for the purpose.

(2) I tried stretching the tape on the table and wiping across the splice with a small bar magnet, using a sweeping action which brought the magnet down in a shallow arc. This "faded" the signal itself quite nicely, but produced a sharp rise in noise level which was quite noticeable. I didn't like that method either.



(3) The tape recorder was switched to "record" with the level at zero, and the tape held away from the heads with a pencil. The drive motor was then switched on and the tape lowered smoothly against the erase head as the splice passed, the tape then being lifted slowly away again. This produced a somewhat tremulous fade, and was a big improvement on the original.

But how easy it would be to make a mistake and wipe the wanted material accidentally! I was getting nearer the mark, however.

(4) The method which proved successful is simplicity itself. I stretched the tape out tightly in mid-air, with the splice clearly visible. I took a standard bulk erase transformer in the free hand, switched it on and brought it up in a sweeping arc toward the splice. The transformer was held against the splice, then moved slowly away from it and the surface of the tape in a second sweeping arc.

Since the splice was clearly visible all the time, there wasn't much chance of making a mistake.

Reassured by the first test, I went ahead and treated the troublesome splice in the wanted tape.

On playback, after the said treatment, the effect was exactly similar to a rapid manipulation of a couple of program faders. The voice faded over the last couple of syllables, and the music took up in like fashion, with not a sound in between to suggest a splice.

This experience suggests two possible devices which might be very useful for tape editing. Of course, someone may have invented them already!

The simpler one would consist simply of a few laminations and a coil of wire made up in the form of a probe and fed with 50-cycle current, possibly from a filament winding. It would be used to erase or de-sensitise small sections of a stationary tape in the manner I have just outlined.

The second device would be much more pretentious, being part of a complete editing machine or a normal three-head recorder slightly modified.

The essential features would be a playback head and amplifier, preceded, in the tape run, by an erase head and its RF supply. This supply, however, would be an oscillator/amplifier circuit with a control which would allow the erase field to be reduced smoothly to zero.

By watching a script and listening via the playback amplifier, an operator could deliberately "fade" through a two-abrupt change, simply by increasing and decreasing the RF in the erase head.

The same device could be used to attenuate excessively loud sound effects or bridge music, or perhaps "round off" sudden changes in level.

By masking the limits of the field sufficiently, it may be possible to use a 50-cycle erase for the purpose, though I am doubtful.

I am well aware, of course, that electronic "fading" of this type would be frequency conscious, the treble disappearing before the bass. But I don't think this would matter in most cases, the "end" more than justifying the means.

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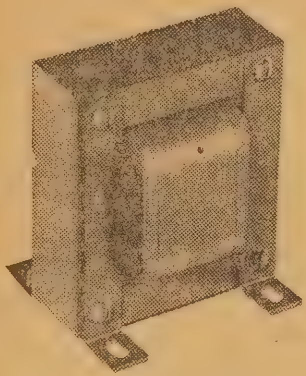

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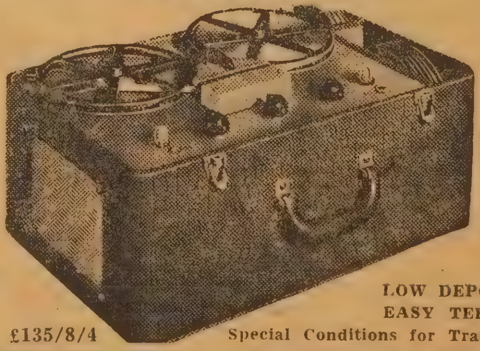

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FROM THE SERVICEMAN WHO TELLS

I have a variety of matters to discuss this month, ranging from hazards of battery charging to the design of some receiver components. On the more routine side of things there is a receiver with a particularly puzzling fault.

MOST of my readers, like myself, have probably indulged in their fair share of battery charging in the course of their work or hobby, and doubtless regard such a job as a simple routine, free from serious problems or hazards. I hope you do, anyway, because I will then be justified in setting out to disillusion you!

Take that word "hazard", for example. You might think it an exaggeration to classify battery charging as a hazardous occupation, but let me hasten to assure you that it can be—if you don't keep your wits about you.

DANGEROUS GASES

You have probably all read, or been told, at some time that the gases given off by a battery on charge form an explosive mixture and that naked lights, cigarettes, and so forth should be kept well away If you're an average type you have probably also dismissed such warnings as being more academic than practical and, in any case, hardly likely to affect you.

Well, I thought that too, once, but let me tell you how I was converted.

Many years ago, when I was but an inexperienced youth, I was employed as a techinical offsider to a serviceman in a large country town. Naturally a large section of the business was devoted to battery sets and to the charging of the batteries belonging to their owners. A large part of this latter work was allotted to "yours truly".

For the job we employed a simple Tungar type charger capable of charging at about five amps and over a wide range of voltages. Because of the limited current rating, the only way in which a number of batteries could be charged simultaneously at a reasonable rate was to connect them in series, thus making available the full charge rate of 5 amps for each battery.

A CARELESS HABIT

When a particular battery was required to be taken off charge it was the custom to simply unclip the two leads from it, clip them together to restore the circuit for the remainder of the batteries, and adjust the charger to allow for the reduced voltage. All this would be done without bothering to switch off the charger at the mains.

I must point out, in self defence, that this custom was firmly established before my advent on the scene and that I simply acquired the habit by observation. As I remember it, the main switch for the charger was located some distance from the unit itself and in a not very accessible spot. This, no doubt, was the primary cause of this custom being started, plus the fact that it did appear to save a few precious moments when things were rushed.

Came the day when a customer rang up to enquire whether his battery was charged and, on being told that it was, advised that he would be in town in a few hours to collect it. When I hung up the phone I went straight to the battery bank to take the customer's battery off charge. Actually it had reached the full charge condition about two hours previously and was now, as the text books say, "gassing freely".

Without any thought of the possible consequences I commenced to disconnect the battery. A moment later I was leaning dazed against a wall, wondering what on earth had happened to me, for, at the moment I broke the circuit, there had been a blinding flash and a deafening roar.

BAD FRIGHT

I had been alone in the shop at the time but the sound of the explosion had echoed through the adjacent departments and other members of the staff came running to find out what it was all about. I think some of them were surprised to find me still alive and I know I was rather surprised myself when I realised I was unhurt. In fact, I was more frightened than anything else, and I doubt whether the force of the explosion, terrifying though it was at close quarters, would have been sufficient to inflict any injury.

However, when I had collected my thoughts a little, I realised that I had been very fortunate in another respect, for almost every part of me, except my face, had been sprayed with acid, and my hands and arms now began to sting rather alarmingly. A solution of bicarbonate of soda and water, liberally applied, soon gave me relief, but I still shudder when I think of what might have happened if my face and eyes had been sprayed as was the rest of me. Needless to say, my clothes, fortunately old ones, were a complete "write off".

But the real casualty was the battery. Such was the violence of the explosion that not a scrap of the case remained, the plates sitting forlornly among the remaining batteries for all the world like an embarrassed bather who has suddenly lost his trunks.

It was while I was ruefully surveying the damage that the boss walked in. He had already heard something of the story and when he had heard my version he waited only long enough to make sure that I was not hurt before telling me off in no uncertain terms for being so careless. Naturally there was little I could say in my defence, for I really should have known better and the fact that I had seen others do the same thing could hardly be advanced as an excuse.

Fortunately, the boss was a reasonable man and he soon cooled down. We cleaned up the mess, found a spare battery to keep the owner happy for the time being, and despatched the battery plates to the makers in Sydney to be fitted into a new case.

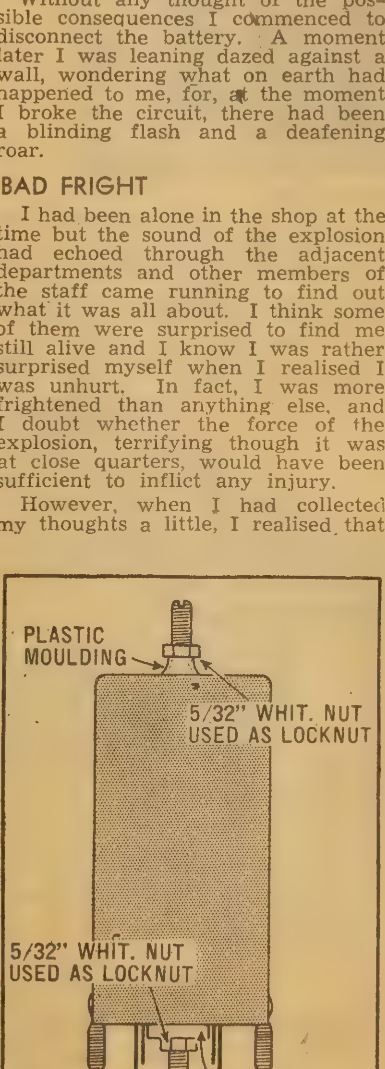
ENCORE

Finally, an explanation had to be made to the owner as to why his own battery was not ready. The boss explained that he had discovered it to be a defective case (how true!) and that, as we may have been responsible, he had taken the liberty of sending it to makers to have a new case fitted.

When the excitement was all over I made a solemn vow that I would never again disconnect a battery which was still on charge.

But this is not the end of the story. Three days later exactly the same thing happened, only this time it was I, along with other members of the staff, who came running into the workshop to find the boss sitting dazed in the corner opposite the battery bank, while another battery, minus its case, stood dejectedly among its fellows.

Exactly what happened I never found out, but the boss' story was that he was checking over the battery bank for a faulty connection and, like the man looking for the gas leak with a candle, he found it. Human nature being what it is, I'm afraid I had quite a gloat, inwardly at any rate, and felt strongly tempted


PLASTIC MOULDING
5/32" WHIT. NUT USED AS LOCKNUT
5/32" WHIT. NUT USED AS LOCKNUT
PLASTIC MOULDING

IF transformers or other coils which suffer from loose iron core adjusting screws can usually be improved by fitting an extra nut as a locknut. Once locked in this manner, a core is not likely to move.

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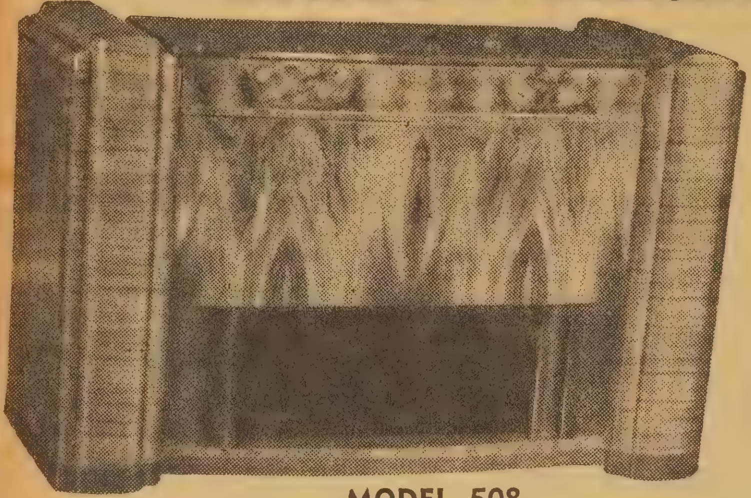

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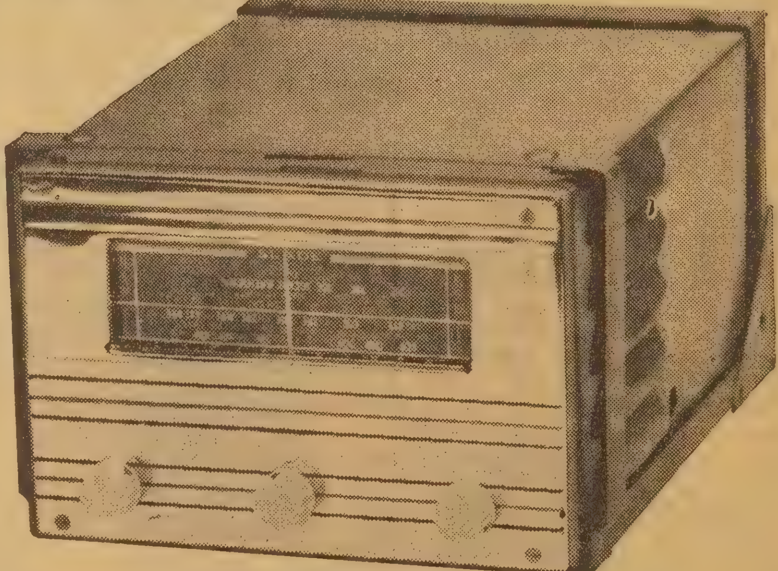

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to repeat some of the remarks which had been made to me three days before. However, he was the boss and I was only the boy around the place, so I shut up.

The explanation for all this is relatively simple. When a battery is being charged, and particularly toward the end of the charge, two gases, hydrogen and oxygen, are given off, one from the positive plate and the other from the negative. (Don't ask me which is which; it really doesn't matter, and I would have to raise myself out of a comfortable chair and search through a reference book to find out.)

The real point is that hydrogen, when mixed with the atmosphere, forms a very explosive mixture. With pure oxygen it becomes really potent. Such a mixture is easily ignited by an electric spark, so that the simple act of disconnecting the battery from the charger was quite enough to produce the ideal conditions for an explosion.

CORRODED TERMINALS?

Much the same thing happened the second time, except that it was probably some corrosion on either the battery terminal or the clip connected to it, which caused a faulty connection, and hence a spark when it was disturbed. In fact, of course, it would be quite possible for such a faulty connection to create a spark spontaneously, so that a battery could easily explode without any apparent cause.

My main reason for citing the above cases is not so much to emphasise that the gas is explosive and that it can be ignited by a spark, as it is to give some idea of the violence of the resulting explosion, the damage it can cause and the danger to anyone nearby. At the same time, the fact that the same accident happened twice within a few days quickly dispelled any doubt which I may have had about the first one being a freak.

In fact, I heard of another similar case only a few weeks ago, when a colleague who was checking a bank of batteries used for blackout lighting was unwise enough to disconnect the lead from the charger while the battery was gassing.

The resulting explosion was not violent enough to damage the battery case, though it still made enough noise to scare the wits out of my friend. It did, however, lift the stoppers out of several cells, where they had been resting lightly, and hurl them with considerable force against a high ceiling.

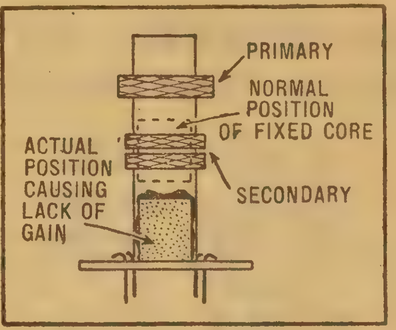
PRIZE STORY

And the final story about exploding batteries, I think, really takes the prize.

It concerns a young apprentice in one of our radio and electrical factories who, apparently, had a very inquisitive nature. The department in which he worked made extensive use of batteries for testing various pieces of apparatus and a number of benches were equipped with several small cells and a charger to keep them fully charged.

One day our young friend noticed that one of the batteries was bubbling merrily and obviously giving off a gas of some kind. Now this is where the inquisitive nature of the youth makes itself apparent. Was it, he thought, an inflammable gas? Would it burn, and how violently, if ignited? Well, there was one way to find out. No sooner had the thought entered his head than he whipped out a box of matches, struck one, and held it over the open vent of the battery.

With a roar the battery case disintegrated and a wave of acid swept over the bench and all the equipment stacked thereon, while our friend staggered back and muttered something about not knowing it would do that.


PRIMARY
NORMAL POSITION OF FIXED CORE
ACTUAL POSITION CAUSING LACK OF GAIN
SECONDARY

Much trouble was caused by an iron core which came loose from its moorings and dropped to the bottom of the former. When the set was inverted sensitivity was normal, but dropped when right way up.

Needless to say, considerable damage resulted, not only to the battery, but also to the equipment on the bench. When the boss of the department, normally a very tolerant man, realised fully what had happened his comments were quite as vitriolic as the acid which had just been spilt and our friend was very much "in the dog house" for several weeks.

All of which has served to convince you, I hope, that batteries can be quite dangerous if not handled with reasonable care and that there is plenty of justification for such precautions as turning the charger off before making or breaking the connection. Avoid flames and cigarettes at close quarters and see that clips and terminals are not corroded and likely to produce a spark due to poor contact.

A READER'S CASE

And now, bfore going on to deal with some of my own experiences for the month, I want to quote from a letter sent to me by a New Zealand serviceman. He is Mr. R.F.C., of Dargaville, and he writes as follows:

"This case concerns auto radio of well known New Zealand make. The owner complained that he couldn't get the stations at any strength at all, the set being just plain 'gutless' After considerable difficulty I succeeded in removing it from the car and set it up on the bench. The usual tests showed everything to be apparently OK. Current drain was normal, as were the voltages and tubes. The IF alignment was no more than a fraction out and showed plenty of gain.

"At this point I admit I did a spot of head scratching.

"With the antenna plugged in and the set tuned to a station I happened to turn it upside down. Instantly it leapt to life and stations roared in. Puzzled, I re-inverted the works and the signal died to a whisper. This happened every time I cared to try. Hot on the scent I poked and prodded at every wire and component, only to draw a complete blank. Every thing seemed one hundred per cent and yet, turning the whole set back and forth still produced the same result.

"By process of elimination I tied the trouble down to the RF stage. After a while I noticed that every time I turned the set over there was a very soft thud. It sounded like a lump of putty sliding up and down a tube. You have it? Right. The fixed iron core in the RF coil had broken free from its moorings and was sliding freely up and down the former. A careful poking into position and some wax poured down the tube fixed the trouble.

"Actually I was lucky. If the slug had moved out of position and then jammed, I might be looking yet."

Thanks, Mr. R.F.C., for a very interesting and unusual case. So far I have not struck one like this, though I did hear of one factory who had several such cases in the early days of iron-cored coils. Fortunately, most of them gave trouble before they left the factory and so were fairly easily dealt with, though I believe the first few set the technicians scratching their heads until the word was passed around.

VIBRATION PROBLEMS

While on the subject of car sets it is perhaps worth while to point out that due consideration is not always given to the conditions under which they operate, either by the original designer or the serviceman. No. 1 enemy of such equipment is undoubtedly vibration, and it is surprising the varied effects which this can cause.

A case in point was a Radio and Hobbies Karset which recently passed through my hands for a more or less routine repair and check-up.

The main point that struck me when I removed the major defect was that the performance, though good, was not as good as it should be for a set of this type. A check on alignment revealed nothing significantly out of adjustment until I connected the set to its own aerial and checked the aerial trimmer, when it was found that this was hopelessly out of alignment.

Since I have every reason to believe that the trimmer was correctly adjusted when the set was originally installed, I can only assume that the continual vibration had slowly unwound the adjusting screw, even though it appeared to be quite tight when set.

After adjusting correctly again I endeavored to seal it in place with some lacquer and which I can only hope will be sufficient to withstand the vibration, though a better quality trimmer, with some positive locking device, would be a far better proposition. Perhaps some go-ahead manufacturer will oblige by producing such a component.

While on the subject of components, a pet grouch I have is the iron-cored coil, in which the core is so sloppy that even the vibration from the speaker is sufficient to cause it to slowly wind its way downward, thus completely ruining a careful alignment job if one has not had the foresight to seal everything very carefully before the set is moved.

Even accurate alignment becomes difficult with such cores because they frequently wobble about sufficiently to cause appreciable variation in

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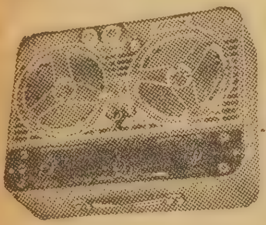

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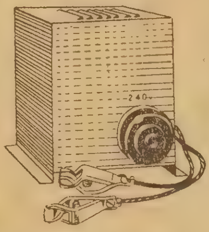

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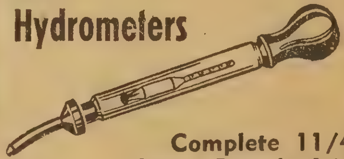

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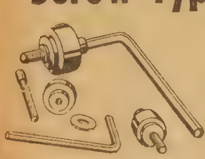

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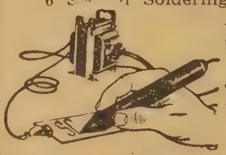

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tuning whenever the pressure of the adjusting driver is applied or removed.

The best cure I have found for these is to run a nut on to the threaded portion (5-32in. Whit. is the usual size) and use this as a lock nut. It may be run down against the threaded portion of the former and held moderately tight while the final adjustment is made, then fully tightened to prevent any chance of further movement. A short tube spanner is handy for the job, though a pair of pliers is all that is needed on many types.

This is a far better arrangement than "butchering" the thread with a pair of side cutters, which is a procedure adopted by many servicemen, while some factories have, in the past at any rate, regarded this as a standard step in the final alignment and check

MYSTERY SET

And finally we come to the mystery of the month. In this case the set belonged to a relative and his story was that he had left the set running while doing some odd jobs around the house. A sort of "music-while-the-wife-makes-you-work" idea, with just sufficient volume to find its way into various rooms and provide a pleasant background to a job of painting or laying lino.

After a while he realised that the radio was no longer giving forth sweet music, and also, when he stopped to think about it, that it had been quite silent for the previous 15 or 20 minutes. Further investigation showed that the set was incapable of receiving any signals and, in addition, was giving forth a horrible smell of burning. Very wisely, he switched it off, later to tell the sad story and ask what I thought was wrong.

"Elementary, my dear Watson," I replied, adopting my best Sherlock Holmes attitude and wishing I had a deer-stalker cap and meerschaum pipe to heighten the effect. (After all, being my own relative, I could afford to lay it on thick.)

"We will find, upon careful examination, that the first electrolytic condenser has failed. From the length of the inoperative period, which you were so careful to observe, it is only a matter of simple deduction to be able to state that the rectifier will also be a total casualty.

"We may further deduce," I went on, before he had time to interrupt, "that the smell of which you complain came from the power transformer, this component having suffered a severe overload by reason of the shorted electrolytic and for just as long as the rectifier could keep up the unequal struggle.

"In all probability, therefore, the power transformer has also been damaged beyond repair, though there is a faint chance that the rectifier may have failed before any permanent damage was done."

My "audience" shook his head in bewilderment. "Beats me how you can tell all that from a smell, particularly when you haven't even smelt it."

"Nothing to it, my dear fellow," I replied condescendingly. "Long years of practice and all that you know. But enough of this chit-chat. Let us examine the offending device and confirm my diagnosis."

Which we did. At least, we examined the thing, but it soon became evident that all was not going to work out according to plan. Certainly there was the unmistakable smell of a power transformer which had been very hot, but a preliminary test, made by switching the set on without the rectifier, showed that the transformer was still functioning, at least as far as the filament circuit was concerned.

At this stage I merely assumed that the rectifier must have failed early in the piece and that the transformer had simply become a little hot under the collar without actually wrecking itself.

While we drank tea and chatted about other things, I allowed the set to run, minus the rectifier, for about 15 minutes on the assumption that any shorted turns in the transformer would show up in this time as overheating. When it was only mildly warm at the end of this time I pronounced it as being undamaged and prepared to resume a more professional role.

Next I checked the first electrolytic with the ohmmeter and was surprised to find no evidence of a short.

While strange things do sometimes happen when a higher voltage is applied, the ohmmeter test can usually be taken as satisfactory, so I checked the second electrolytic. This also checked good, as did the entire HT circuit of the receiver. So far as I could tell, there was no reason why the power supply should ever have shown any signs of distress.

EVERYTHING WORKS

Cautiously, I plugged in the rectifier, keeping one hand on the power switch in case of fireworks. Actually, all that happened was that the speaker gave forth music and that the set appeared to be functioning normally. A thorough check of all operating voltages, total HT current and the valves failed to reveal any abnormality of any kind and there was absolutely nothing to indicate why the set had originally failed.

At this point I felt the mantle of the great Holmes slipping quickly from my shoulders as I realised that the problem was not so "elementary" after all.

The only thing left to do was to let the set run for a reasonable period under observation, in the hope that the trouble would recur. Alas for my last hope. A couple of days of subsequent running on the bench failed to reveal a thing and I was forced to return the set with the rather meek admission that I could find nothing wrong with it.

In the normal way I would have kept the set longer in the hope that the defect would eventually show up if only my own, and the owner's, patience would hold out. However, since it involved a relative, I decided it would be safe to allow the set to go back into service on the understanding that the trouble could recur and that it would be unwise to leave it unattended.

Puzzle: Was it a mechanical short or a rare instance of a "dry" electrolytic healing its own breakdown?

So there, for the moment, things stand. What caused the original trouble is anybody's guess, but I am hoping that before very long I will receive an urgent call that things are happening again. When it does, I shall drop everything in the hope of getting there before the gremlin gets away.

In the meantime I can only wait and hope.

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Here's your answer, Tom!

We received a very long and serious letter from Tom a few weeks ago. Apparently, the remarks we have made from time to time about his tendency to jump from subject to subject with gay abandon have at last begun to have some effect, because he would now like us to tell him the story of radio valves.

HE explains that he already has a rough idea of what diodes, triodes &c. are and what they are used for but there are quite a number of gaps in his knowledge of the subject.

Then there are such things as phototubes, thyratrons, ignitrons and various other "trons" that keep cropping up but which he doesn't understand at all. Could we help?

Well, we thought about Tom's suggestion for quite a long while. Perhaps he had something. After all valves are so intimately connected with radio and electronic devices these days that you simply can't get very far unless you thoroughly understand them.

A LONG STORY

As for telling the complete story of radio valves, we could go into a lot of historical detail about who invented different ideas &c. which would perhaps make very interesting reading. The difficulty is that it would take a long time to cover all the facts that you need to know. So perhaps, Tom, it would be better if we leave the cultural side of the subject for the time being and concentrate on the technical. You can believe us that there is plenty to keep you interested for a long time.

Then we thought about where we should start. If we assume that you know all about electron theory and thermionic emission you may lose the thread of the discussion before we start whereas on the other hand there is a possibility of spending a lot of time on detail with which you are already familiar.

Therefore we have decided to adopt a middle course and while you will read about things with which you are already familiar, there will be plenty of new material into which you can bite your teeth.

Without any further preliminaries, Tom, we will get on with the business in hand.

A study of valves is largely a study of the movement of electrons in evacuated, or in some cases gas-filled, envelopes. As a matter of fact they are frequently called "electron tubes."

If we are going to talk about electron tubes, it would be a good idea to know what an electron is. That isn't so easy.

Everybody knows what a pound of butter is. You probably see one nearly every day of your life. But nobody has ever seen an electron!

You can't put an electron on a plate, hold it and say, "Here is an electron."

Then how do we know that there is such a thing as an electron? The answer? We only think we know!

The idea of electrons, protons, neutrons, atoms and molecules is an elaborate theory that has been invented over a period of time to explain things that happen in nature. It is a good theory because it "fits" and is apparently verified by most things and, unless you become an atomic scientist later on, Tom, you won't have any need to dispute it.

Perhaps at some stage, Tom, you have taken a piece of something and cut it into two pieces with a knife. Then you may have taken one of those pieces and cut it into two pieces. Then again you have taken one of the latter pieces and cut it into two again.

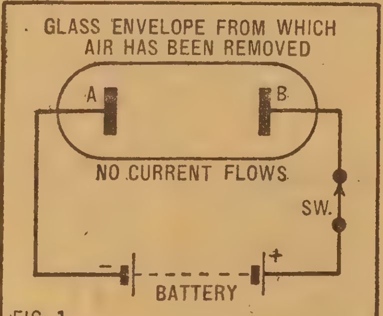

FIG. 1

By this time the smallest piece is so small that you can't cut it with a knife, so you take a sharp razor blade and cut it in two again.

You may have wondered how long it would be possible to go on doing this given all the clever instruments there are. Could you keep on for ver with the piece of material getting smaller and smaller or would you eventually reach a stage where the tiny bit of material would refuse to be divided again?

The answer, according to the theory, is that you would eventually reach a stage where to divide the material further would cause it to lose the special characteristics of the particular material. You then have what is described as a "molecule" of the material.

Even though it is so small that the eye could not possibly see it, a molecule of a particular material has the properties of the material. A molecule of lead is different from a molecule of copper &c.

Each molecule is made up of atoms. It may contain many atoms or only one or two, depending on the substance.

The atom, in turn, is made up of other small particles, the most important of which, as far as we are concerned, are protons and electrons. It is arranged something like a miniature solar system, with the proton or protons occupying the position of the sun and the electrons revolving around it like planets.

There may only be one proton and one electron in a particular atom or there may be dozens. The number of protons and electrons in the atom governs characteristics of the material.

Sometimes different combinations of the same atoms go to make up still different materials. You would learn about this in a study of chemistry.

An important point, however, is that an electron from an atom of lead is the same as an electron from an atom of copper. The same applies to the proton. As the theory goes, the proton and the electron cannot be divided farther, regardless of what trouble you take.

ELECTRIC FORCES

Further than this, it is hard to separate the proton and the electron, because they have a strong attraction for each other. The electron has what we choose to call a negative charge, and the proton a positive charge, so that all electrons are attracted to all protons. It is these attractive forces which hold all matter together.

The atoms of some materials (copper is an example) contain a number of electrons, some of which are revolving in orbits at a distance from the group of positively charged protons in the centre and for this reason may tend to wander to the orbits of nearby atoms. Immediately an atom loses an electron in this way, another

about electrons...

electron from a nearby atom will move in to take its place. The result is that in a material such as copper there is a continual random movement of electrons.

If you take a piece of copper in the form of a wire and by some means provide a deficiency of electrons at one end and a surplus at the other, the out-of-balance will be neutralised almost instantaneously because the electrons will be attracted to the protons at the other end. When this happens a current of electrons flows for a small time, or, if you like, an electric current.

In the case we have described the current would flow only for a very short while, but it is possible to make it flow continuously by connecting a battery, one terminal to either end of the wire.

ELECTRON FLOW

The atoms of some materials do not possess free electrons, so that they do not allow the passage of a current of electrons. Such materials are called insulators. They are just as important as conductors because they allow us to prevent electric currents flowing.

Well, Tom, it's taken quite a bit of time to give even a summary of the atomic theory, but as you read on you will realise that it was well worth while.

By means of batteries or generators, electrons can be made to flow in wires and produce many useful effects. For example, an electric current flowing in a wire produces a magnetic field. This magnetic field can be used to make an electric motor. Then again, a current flowing in a wire produces heat, which can be employed in many useful ways.

But our interest at the moment is in valves, or electron tubes, which produce the most versatile known means of controlling the flow of electric currents.

An electron tube usually has a glass envelope from which all air and other gases have been removed. The electrons are then able to move around in the space inside the envelope without bumping into atoms of air. There are special cases when gases are introduced into the envelope deliberately, but we will talk about these later.

Figure 1 illustrates a very simple device, which is the starting point for our discussion of electron tubes. It represents a glass envelope containing two plates of conducting material and from which the air has been removed. The plates are connected by means of conducting wires, one to each of the terminals of a battery.

SIMPLE ELECTRON TUBE

The plate marked A is connected to the negative terminal of the battery and therefore has an excess of electrons while the plate marked B has a deficit of electrons being connected to the positive terminal of the battery.

The electrons on plate A are attracted toward those on plate B but unless the battery is able to exert a very great electrical pressure, or voltage, no electrons will be able to flow from one plate to the other.

Many of them will be drawn over to the side of plate A nearest plate B. This side of the plate will then have a negative charge and the other side of the plate a positive charge. Because this latter positive charge is very much closer to the electrons than the positive charge on plate B it is usually successful in preventing the electrons from moving outside the material.

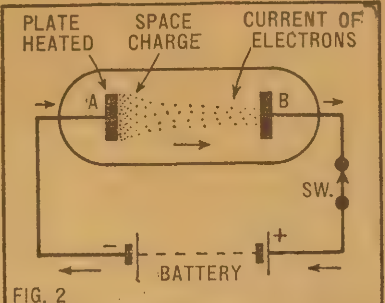

FIG. 2

The forces of attraction inside the material of the plate can be overcome only if a strong charge be applied to plate B and if the two plates are close together. When this happens, some of the electrons will trave across the space from plate A t plate B. In practical electron tube we usually do not want this to happen so we make the spacing insid the tube great enough to withstan the voltage we wish to apply.

There are other ways in whic electrons can be pursuaded to leav the surface of the plate, or b **emitted** as it is generally called. I practice these other ways are fa more important than the "brut force" method of applying highe and higher voltages.

Forgetting the battery and plat B for a moment, let us imagine tha plate A is strongly heated. Th countless molecules making up th plate will begin to vibrate mor rapidly and the electrons which mov about in a random fashion will als begin to do so more rapidly.

When plate A is heated so muc that it becomes a red or a whit heat some of the electrons will gai so much velocity that they will b able to overcome the attraction of th protons and leave the surface of th metal.

The metal will thereby gain a posi-

(Continued on Page 95)

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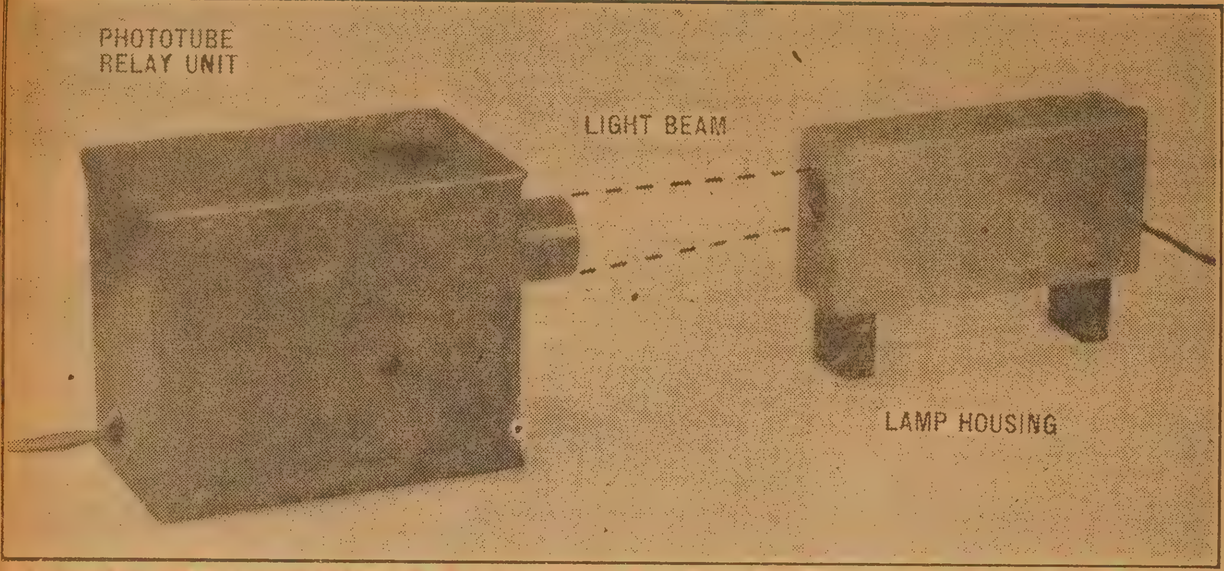


A general view of the completed photo-cell unit and lamp house. In most cases the distance between the two units will be much greater than this and satisfactory operation up to 25ft is possible with a small lamp. Larger lamps will give a greater range.

LIGHT BEAM GUARDS DOORWAYS

Photo-electric cells are fascinating devices and if you have ever considered experimenting with them here is your chance to get started. The unit to be described is a thoroughly practical device capable of many applications, though that of "shop minding" is probably the one having most appeal.

A POPULAR belief is that equipment for use with photocells is complicated and expensive, whereas, in fact, nothing could be further from the truth. The unit which we will describe later in the article uses far less components than even a simple radio receiver, yet is a completely reliable device having ample sensitivity and able to hold its own against similar commercial units.

Although there are plenty of ways in which this basic unit may be used, the one we have in mind as most likely to appeal to the average reader is that of a "shop-minder". In this application a beam of light is focused across the shop doorway and allowed to fall on the photo-cell. The associated circuitry is so arranged that, while ever the light is present, a pair of relay contacts are kept in the open position.

REDUCED LIGHT

However, as soon as the light is removed from the cell, even for a fraction of a second, the relay is energised, the contacts closed, and any kind of alarm to which the contacts are connected will be operated. This means that it is virtually impossible for anyone to enter the shop without sounding the alarm, even if they know that the system is in operation. In most cases, they need not know!

A system such this will appeal particularly to the one-man service shop, where the proprietor will normally spend most of his time in the service department at the rear of the shop. Even when the working position is most favorably placed to watch the shop (and this ideal condition is not always possible) it is extremely difficult to concentrate on one's job and still effectively "keep an eye on the shop".

by Philip Watson

Customers dislike being kept waiting and impatient types are just as likely to walk out if not acknowledged immediately.

There is also the very real possibility that some of the "light-fingered" members of the community, once they discover that they can enter the shop without being noticed, will slip a mantel set under their arm and walk out. The writer knows personally of at least one case where this has happened.

In these circumstances a photo-electric "shop-minder" can take over the entire job of "watching" the entrance to the shop and the proprietor, relieved of this irritating responsibility, can concentrate on his work secure in the knowledge that no one can enter the shop without announcing their presence.

POSITIVE ACTION

One of the features of these systems is that it is almost impossible for "smart" customers to "beat" them. The same cannot be said for mechanical systems involving floor contacts, because people very soon learn where to step in order to avoid operating them. Furthermore, floor contacts are easily affected by dirt and, when they do give trouble, it is usually necessary to pull half the floor up to service them.

So much then for some of the advantages of the device. Before describing its construction, a few words about the theory of operation of the photo-cell and its companion tube, the thyratron, may assist the reader to understand better just what goes on.

The type of cell in which we are interested at the moment is the photo-emission variety, the operating principles of which are similar to the ordinary valve. For this reason most readers should have little difficulty in understanding them.

Such a cell consists of a glass envelope mounted on a base similar to a valve and containing two elements, a cathode and an anode (or "plate"). In some cases the interior is held at a high vacuum and in other cases a small quantity of inert gas is introduced after the air has been pumped out. The difference in the operation of these two types we will discuss in a moment.

The vital part of the cell is the cathode, which is light sensitive in the sense that it emits electrons whenever light is allowed to fall on it. In most cells the cathode consists of slightly curved metal plate coated with a thin layer of the light-sensitive material. The area of the cathode is made fairly large in order that as much light as possible may be intercepted.

PHOTO-ELECTRIC EFFECT

Various substances exhibit the characteristic of releasing electrons when subject to light, but two which are most frequently used are caesium and potassium. The main difference between them is that caesium is sensitive to red and infra-red light, while potassium is sensitive to blue, violet and ultra-violet.

The other element, the anode, does not normally bear much resemblance to valve counterpart, the plate, and usually consists of a thin metal rod mounted in front of the cathode. Thus it impedes very little of the light directed at the cathode, while the small area is adequate for the small amount of current to be handled.

In operation the anode is made positive relative to the cathode, so that whatever electrons are released from the cathode by the action of light will be attracted to the anode, thus providing a path for current to flow from the external voltage source.

In order to make use of this current flow it is normal to include a load resistor in the anode circuit, as in a resistance-coupled valve. Current flowing through the load develops a voltage across it and this voltage is applied to a following stage for amplification.

Because of the very low currents normally encountered (one or two microamps are common figures) the load resistor is made very high in order to develop as much voltage as possible and values up to 10 megohms are normally employed.

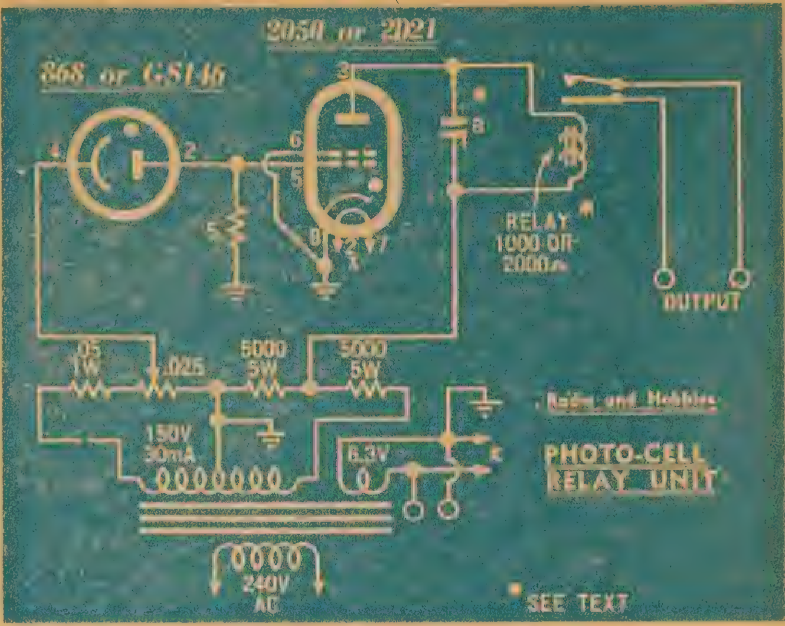
"ORDINARY" CIRCUIT

Thus, apart from circuit values, the photo-cell is employed and behaves very much like a valve. The main difference is that light, instead of heat, is used to energise the cathode and that the electron flow is controlled directly by the cathode, rather than by means of an intermediate grid.

All the above explanation has been on the assumption of a vacuum type cell, but the operation of the gas-filled type must also be considered.

Main purpose of introducing gas into the envelope is to increase the sensitivity of the cell, which it does in the following way: Electrons moving from the cathode to the anode may collide with one of the atoms of gas. When this happens it is likely that an electron will be dislodged from the gas atom and will also be attracted to the anode, thus effectively increasing the number of electrons flowing through the tube.

CIRCUIT DESIGN IS SIMPLE



The circuit reveals that only a handful of standard components are required and that the design is extremely simple. The 8 mfd capacitor could probably be reduced to 2 mfd if a suitable size unit is available. Note the popularity when an electrolytic type is used.

At the same time, the atom from which the electron was dislodged becomes a positive ion (having last part of its negative charge) and is therefore attracted toward the negative cathode. On striking the cathode it will dislodge further electrons, an effect known as secondary emission, thus further increasing the electron flow to the anode. By this means the current in a gas tube may be increased several times over what it would be in a vacuum type cell.

PARTS LIST

- 1 Chassis and potentiometer bracket (See drawings).
- 1 Vibrator box (as used for Kar-set).
- 1 Power transformer 150 volts per side, 30 mA. 6.3 volts 2A.
- 1 Photo-cell type GS146 or 868.
- 1 Thyratron type 2050 or 2D21.
- 1 4 pin socket (See text).
- 1 Octal socket (2050). or 1 7 pin miniature socket (2D21).
- 1 5 megohm 1 watt resistor.
- 1 .05 megohm 1 watt resistor.
- 1 .025 megohm potentiometer.
- 2 5000 ohm 5 watt resistors
- 1 8 mfd electrolytic capacitor.
- 1 Relay 1000 or 2000 ohm coil. 1 pair normally open contacts.
- 1 3 terminal tag strip.
- 1 4 terminal tag strip.
- 1 7 terminal tag strip.
- Flex, hook-up wire, solder lugs, grommets, nuts and bolts &c.
- 1 Lamphouse (See drawings).
- 1 6 volt, 5 watt tail light lamp.
- 1 Lamp holder to suit.
- 1 Lens 1in diameter, approximately 3in focal length.

It is easy to appreciate that the process just described could continue to increase the current flow (so long as light was applied to the cell) until it reached a value which would quickly destroy the cathode. In order to avoid this, it is important that the voltage applied to the cell never be allowed to exceed a certain value, as specified by the makers, and that the load resistor not be reduced below a certain value.

Once a certain critical value of current is reached the cathode no longer depends on light energy for its operation and what is known as a "gas discharge" takes place. This is indicated by a faint blue glow within the cell and, once commenced, cannot be terminated by the removal of light. Only the removal of the HT voltage is effective and if the condition is allowed to persist for more than a few seconds the cell will be permanently damaged.

FAST ENOUGH!

Another effect of the gas in the cell is to make it somewhat slower in response than the vacuum type, mainly due to length of time required for the relatively heavy positive ions to reach the cathode and liberate additional electrons. Even so these cells are still suitable for use at audio frequencies up to 10,000 cps and the gas type cell is invariably used for theatre sound reproduction.

Gas cells are also less stable than the vacuum types, so that the latter are always used where precise measurements of light are required and an instrument is required to hold its calibration over a long period.

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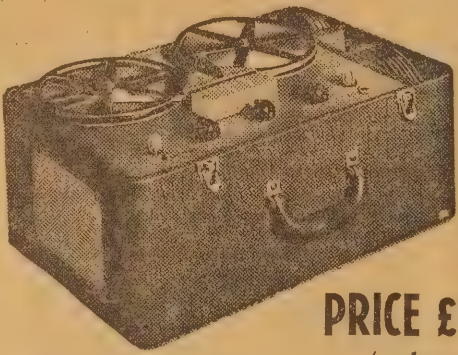

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On the other hand there are plenty of applications where the small variations in sensitivity of the gas type are of no importance but where the increased sensitivity is extremely valuable. The unit to be described in this article is one such application.

The other device which we wish to introduce at this point is the thyratron. Physically the thyratron is similar to a valve into which has been introduced a quantity of inert gas, similar to that used in the photo-cell. Basically the valve is a triode, but in some cases a shield grid is introduced to reduce capacitance between plate and grid. However, the operation of this can be neglected in our initial explanation of the basic principles.

MAXIMUM CURRENT

The presence of gas in the tube has exactly the same effect on the electron flow as in the case of the photo-cell, that is, it causes the electron flow to the plate to increase rapidly from what may be, initially, only a very small flow. In the case of the thyratron, however, the current is allowed to increase to the point where ionisation (or gas discharge) occurs, the cathode in this case being designed to withstand the heavy current.

The internal resistance of the tube when it has thus "ionised" is very low and the current flow is limited mainly by the HT voltage and the resistance of the external load. Care must be taken to see that these values do not allow excessive current to flow or the tube will be permanently damaged, better cathode notwithstanding.

To understand how the tube operates, let us suppose that normal voltage has been applied between cathode and plate, with the plate positive, and that the grid has a large negative potential applied, such that there is no electron movement to the plate. In these circumstances the internal impedance of the tube is very high.

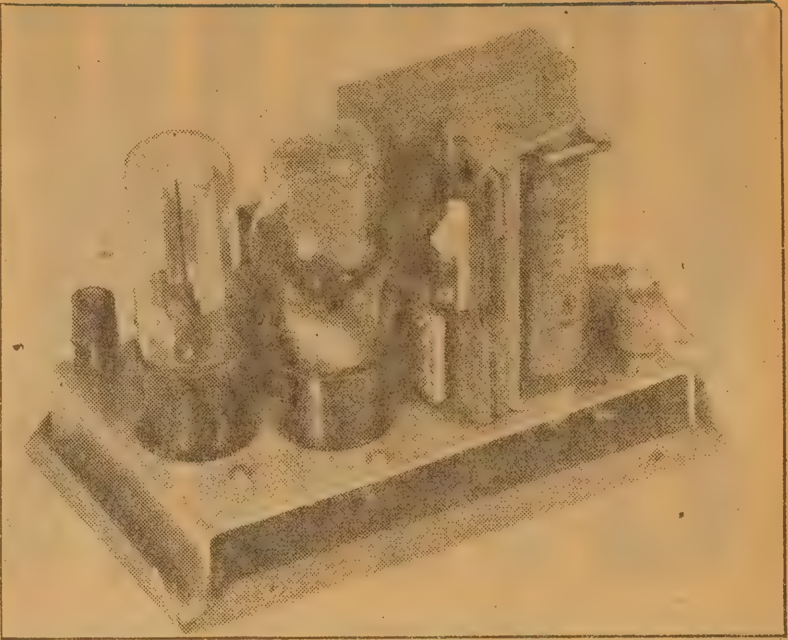
If we now slowly decrease the negative bias we will eventually reach a point where a few electrons will slip through the grid to the plate. Once this happens they will collide with gas atoms and commence the process of ionisation. This will be completed almost instantaneously and the internal impedance of the tube will have dropped to a very low value.

CRITICAL VOLTAGE

The voltage at which the grid allows ionisation to take place is known as the critical voltage. Once the critical voltage has been reached and the tube ionises the grid has no further control and no increase in negative bias will cause the tube to de-ionise. The only way in which it can be de-ionised is to remove the plate voltage.

Summerising then, we may say that the thyraton differs from an ordinary valve in two major respects. One is that the plate current changes from zero to maximum abruptly for a small change in grid voltage, and the other is that the grid can only cause the plate current to increase (by ionisation) but cannot cause it to decrease. While this latter effect may at first appear to be a serious disadvantage it is quite easily overcome, as we shall discover shortly.

BREAKING BEAM CLOSES RELAY



This photograph gives an excellent idea of the general layout. On the left is the photo-cell, in the centre the thyratron, and on the right the relay. The power transformer is behind the relay and the bracket for the sensitivity pot, can just be seen behind the thyratron.

Now let us consider the circuit of a practical unit. Probably the most obvious point about it is that no rectifiers are employed and both the thyratron and the photo-cell have AC applied to their respective anodes. This is quite in order, because both devices will only pass current in one direction and are, therefore, self-rectifying.

This enables the circuit to be simplified considerably and, for the speed of response required in a unit of this kind, is a perfectly satisfactory arrangement. However, as far as the thyratron is concerned, there is a far more important reason why it should be operated from AC rather than DC.

Although specified in this case to operate a bell or buzzer, there is virtually no limit to the type of operation which may be controlled by a unit of this kind, the only requirement being that it can be controlled by an ordinary relay. We may have more to say about this at a later date.

This is to enable the tube to de-ionise in response to a change of grid voltage back to the negative side of the critical point and the operation is as follows: Assume that the grid is initially negative from the critical point and, as a result, the tube is de-ionised from the time of the first application of plate voltage. If the grid voltage is now made less negative until is passes the critical point the tube will ionise the first time the AC voltage makes the plate positive with respect to the cathode.

The tube will remain ionised through the major portion of the positive half cycle, during which time current will flow through the external load. (In this case the relay.)

At the finish of the positive half cycle the plate voltage will be reduced to zero and the tube will be de-ionised, this condition remaining for the entire negative half cycle. During this time no current will flow through the relay which would drop out if it were not for the capacitor across it which has stored enough energy during the positive half cycle to hold it in during the negative pulse.

NEXT CYCLE ?

Whether the tube ionises again on the next positive half-cycle depends entirely on what has happened to the grid voltage during the negative half-cycle. If the grid has remained on the positive side of the critical point the tube will ionise again, but if it has moved to the negative side the tube will not ionise again, thus allowing the grid to once more assume control of the tube.

In this way, that is, by de-ionising the tube 50 times a second while the capacitor takes over the job of maintaining voltage across the load, the grid is able to exercise control over the tube in both directions and can cause it to ionise or de-ionise, depending on whichever side of the critical point it happens to be.

So much, then, for the thyratron. Now, let us examine the operation of the photo-cell circuit.

First point to appreciate is that the circuit is required to operate with a decrease in light, which means that so long as there is light on the cell (above a certain mini-

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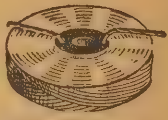

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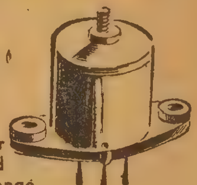

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mum) the thyratron grid is required to be held on the negative side of the critical point and the tube itself to be de-ionised.

As soon as the light is removed rom the cell the grid must swing positive of the critical point, ionise he tube and pull in the relay.

In order to understand how this happens, visualise the 5 meg grid esistor and the photo-cell as together forming a voltage divider ystem across a source of negative voltage. (This side of the transformer winding will be negative with repect to chassis when the other side, upplying the plate, is positive to hassis.) The grid of the thyratron s connected to the junction of these wo sections of the divider so that he voltage applied to it will depend on their relative conductivity.

TUBE IONISES

When there is no light on the cell t may be regarded as an open circuit, so that the grid is effectively returned to chassis. Under these conditions the tube will ionise.

However, as the amount of light applied to the cell is increased, this part of the divider becomes more conducting and moves the grid closer o the negative end of the bias source, eventually making it sufficiently negative to de-ionise the tube.

This is the normal operating condition and any decrease in light will now make the grid less negative, allow the tube to ionise and pull in the relay.

The bias source is also the anode voltage supply for the photo-cell while the 5 meg resistor is fairly obviously the anode load for the cell. In order to adjust the sensitivity of he system to suit the particular ntensity of light available, the voltage applied to the cell is made variable, being returned to the moving arm of a potentiometer.

The voltage across this is normally set at approximately 50 rms, which ensures that the peak voltage applied o the cell will never exceed the maximum figure of 90 as set by the makers.

The remainder of the circuit is fairly straightforward. The two 5000 ohm 5 watt resistors form a voltage divider from which the thyratron plate voltage is derived, this arrangement making it possible to use a standard 150 volt 30 mA transformer.

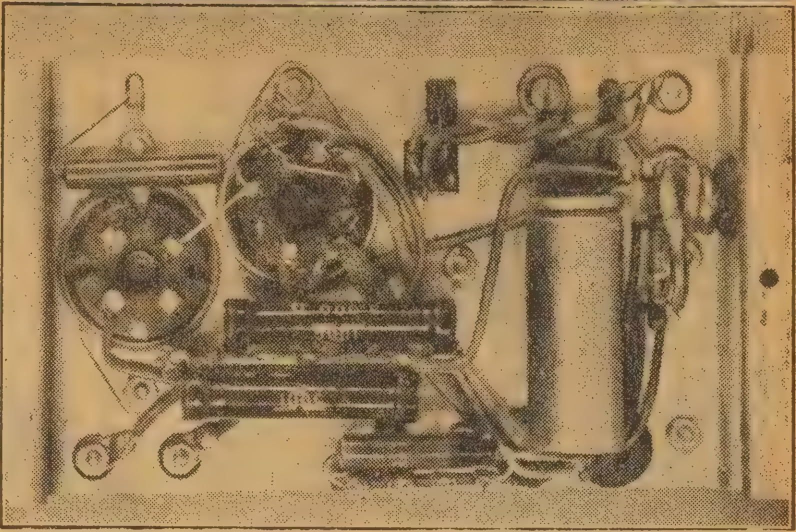
NOT CRITICAL

The relay we used was an ex-disposals type, having a coil resistance of 1000 ohms, and this performed perfectly satisfactorily. It is probable that lower values, say, down o 500 ohms, would be satisfactory, hough much depends on the efficiency of the individual unit. Lower values than this are not likely to be satisfactory.

Higher values, in the order of 2000 o 3000 ohms, should be even more uitable than the 1000 ohms type, particularly where it may be desirable to operate more than one set of contacts.

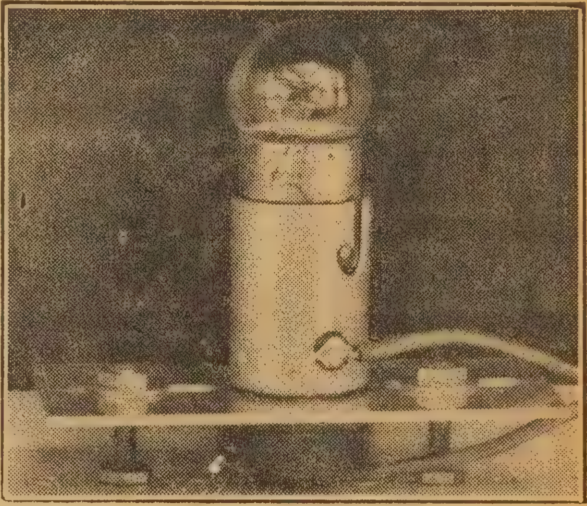
We spent some time investigating he question of suitable relays and we were eventually faced with the nevitable problem, "How much power does it take to operate a reay?" Feeling that it was probably n somewhat the same category as "How long is a piece of string?" but being in need of some kind of guide igure, we contacted one of the makers of such devices.

UNDERNEATH THE RELAY UNIT



This underside view of the unit gives an excellent idea of placing of the smaller components. The two 5000 ohm resistors are mounted on a large tag strip and the .05 meg. on a smaller strip. Note that the photo-cell socket may have to be modified to allow the cell to face in the required direction.

Right is a close-up of the lamp holder and mounting. Note the slots in the mounting plate to allow focusing, and the single hole mounting of the lamp holder to allow the whole to be rotated.



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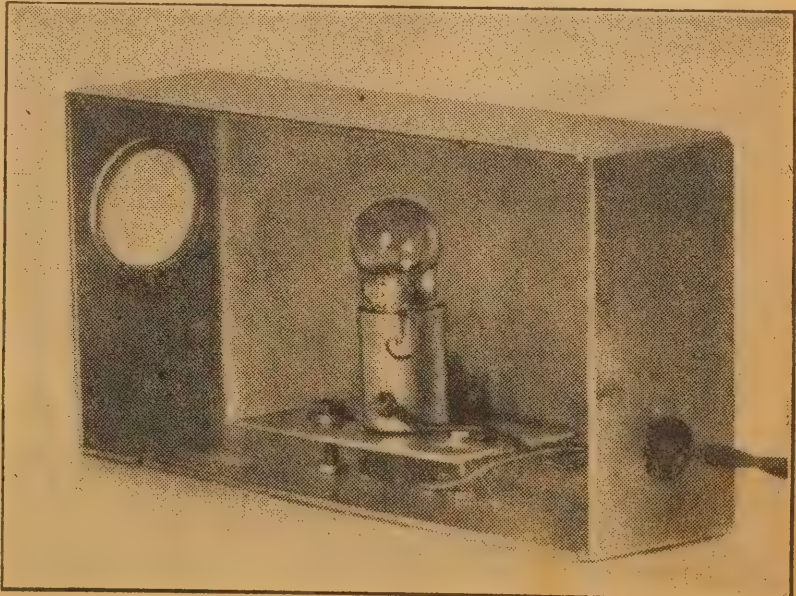
Below is a picture of the lamphouse with lid removed. The lamp is a 5 watt tail light variety and is mounted so that its distance from the lens can be varied to permit focusing for the required distance



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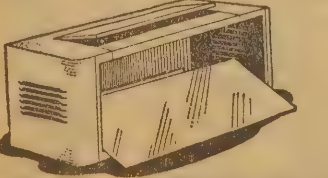

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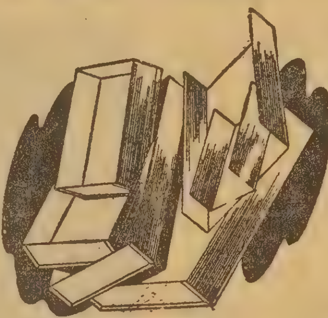

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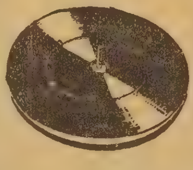

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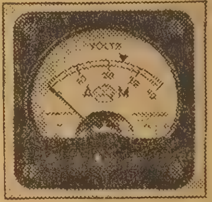

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He agreed that it was not possible to be absolutely definite, but suggested that a figure of 40 milliwatts per spring-set was a very good guide with a fair safety margin. Since this is a problem which besets many experimenters we are publishing the figure as a matter of general interest.

In all probability it could be reuced considerably in many cases, ut, on the other hand, if this figure used absolutely reliable operation hould be obtained.

The contact arrangement of the elay may be selected to suit indiidual requirements, but for the ormal function of ringing a bell, a ingle pair, normally open, is all that required.

SUITABLE VALUES

The capacitor across the relay is a idget 8 mfd electrolytic, the voltage ating not being critical since the pplied voltage will only be in the rder of 10 or 20. In order to obtain he fastest possible response from he relay this capacitor should have o greater value than is required to revent the relay chattering. We ound that a 4 mfd was actually dequate, and in all probability a ower value would do.

However, values lower than 8 mfd re only available in paper types, vhich are both bulky and expensive, nd we finally settled for the electroytic as being the most satisfactory. ctually, although it does make the elay a trifle sluggish, the effect is ot serious and we have yet to find he person who can run through the eam fast enough to beat the relay.

Note particularly the polarity of he electrolytic, which should have ts negative terminal connected to he plate.

The actual construction of the unit s fairly straightforward and reference to the chassis drawing and the hotographs should provide all the nformation necessary to enable the riginal to be duplicated. However, here are a few points worthy of paricular mention.

The box in which the finished unit s housed is a vibrator box originally lesigned for the "Kar-set." This is convenient size, should be readily vailable, and its choice avoids addng another design to the dealers' helves.

HOLE FOR BEAM

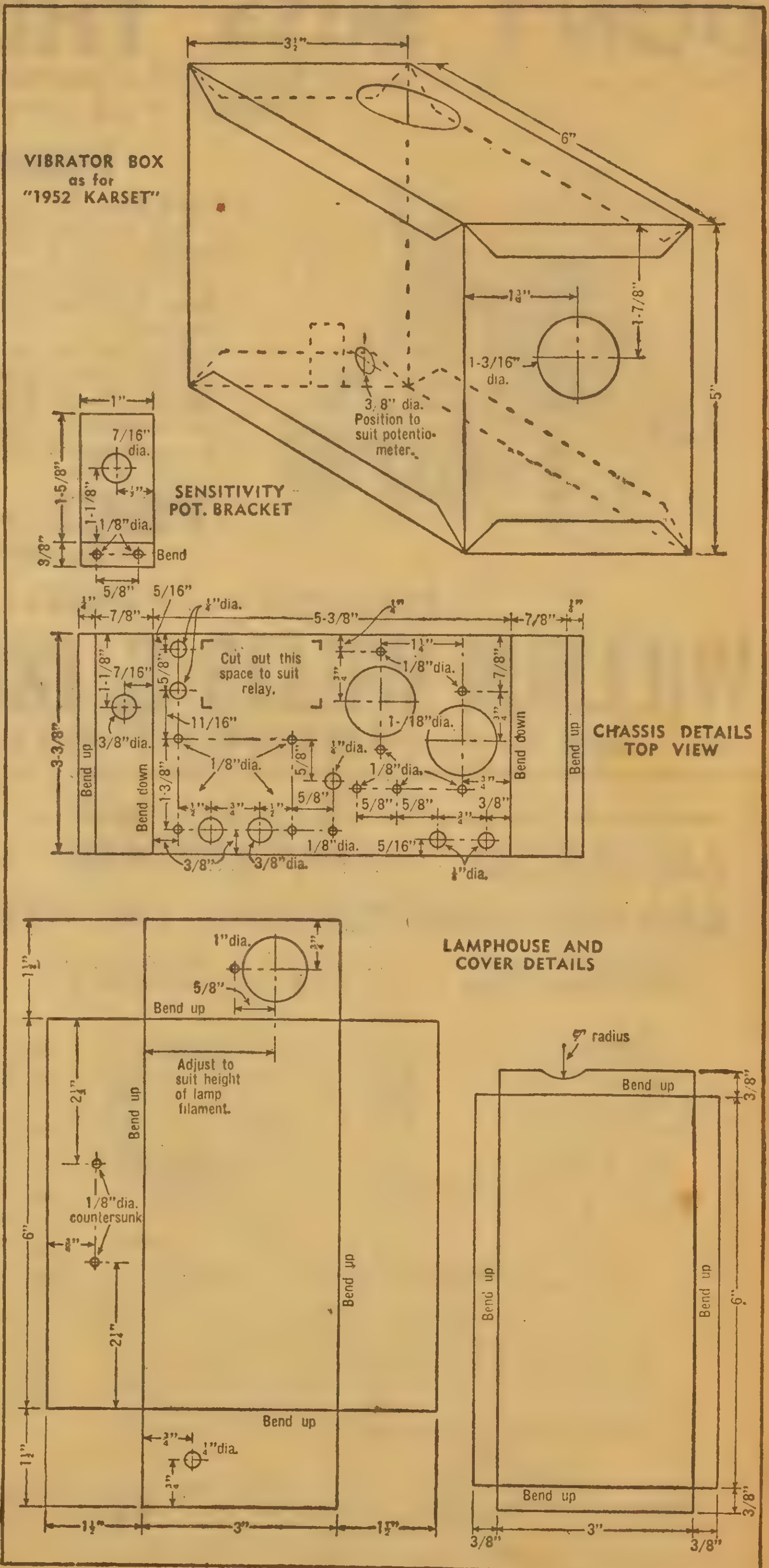
The only modification to the box is hole about 1¼in in diameter in the ront to allow light to pass to the cell nd a small hole in the side to ermit the sensitivity control to be djusted with screwdriver. A small ight hood can be fitted to the front f the box, similar to that shown in he photograph, but should only be ecessary in cases where the ambient ight is high.

The chassis is quite easily contructed from a small piece of aluminium and all the necessary dimenions are given in the drawing.

The four-pin socket to accommolate the photo-cell needs to be selected with due regard to the position of he pins when it is mounted, in order hat the cell will face in the right lirection. We used an "Amphenol" ype but had to rotate the socket roper within its metal holder hrough 90 degrees. The socket is orrectly mounted when the two arge pins face to the front of the hassis.

The sensitivity control is mounted n a small bracket and its shaft cut

CHASSIS AND HOUSING DETAILS


VIBRATOR BOX as for "1952 KARSET"
3½"
6"
1¾"
1-7/8"
1-3/16" dia.
5"
3/8" dia. Position to suit potentiometer.
SENSITIVITY POT. BRACKET
1"
7/16" dia.
1-5/8"
1-1/8"
1/8" dia.
3/8"
5/8"
Bend
CHASSIS DETAILS TOP VIEW
5/16"
¼" dia.
7/8"
5-3/8"
Cut out this space to suit relay.
1¼"
1/8" dia.
1-1/8"
7/16"
3/8" dia.
11/16"
1-3/8"
3-3/8"
1-1/18" dia.
5/8"
Bend up
Bend down
1/8" dia.
1/8" dia.
5/8"
3/8" dia.
5/16"
¼" dia.
LAMPHOUSE AND COVER DETAILS
1" dia.
5/8"
Bend up
Adjust to suit height of lamp filament.
1½"
2¼"
1/8" dia. countersunk
6"
¼" dia.
1½"
3"
1½"
¼" radius
3/8"
6"
3/8"
3"
3/8"

The few metal parts required are so simple that we are publishing this set of drawings on the assumption that most readers will want to make their own. However, ready made parts will probably be available if there is sufficient demand.

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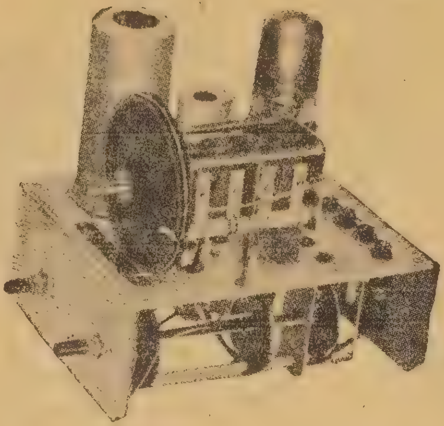

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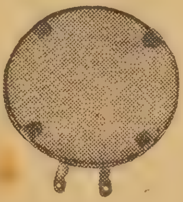

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⅜in

1½in dia. (Rear)

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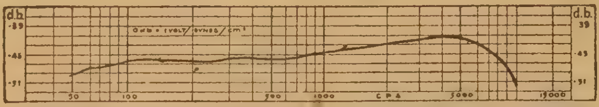

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nd slotted so that it can be adjusted means of a screwdriver through e hole in the side of the box.

Two sets of terminals are provided n the chassis, one set mounting be-nd the relay and connecting to the lay contacts, and the other pair nnecting to the filament supply. urpose of the latter set is to provide source of voltage to operate the mp for the light beam. We will ave more to say about this in a oment.

The layout of the components is ot at all critical and there is no eason why they should not be ccommodated on any convenient hassis which may be available.

To test the completed unit it is ıly necessary to operate it with any easonably strong light falling on the ell, such as a light over the work ench, and adjust the sensitivity con- ol from the earthed end until the elay releases.

CRITICAL SETTING

The point at which it just drops ut will be very critical and only a nall drop in light will be required cause the relay to pull in again. his condition is usually too critical or satisfactory operation and the ad- ıstment should be set to a slightly ss critical position for most satis- actory performance.

Once the main unit is performing atisfactorily we may turn our at- ention to the production of a suit- ble light beam. We considered it ould be most convenient if the mp for this could be operated from e transformer filament winding, hus saving the cost of an additional ansformer. However, the maximum urrent available from this winding two amps and with .6 amp al- eady needed for the thyratron we ere limited to 1.4 amps for the mp.

The lamp closest to these require- ents was a five watt, six volt car ail lamp and we set about finding ut just what could be done with his amount of light. In order to oncentrate the light into a beam we sed a small lens, adjusting the ocus so that an image of the lamp lament was produced on the photo- ell cathode.

SIMPLE LENS

Only a simple lens is needed and e purchased a small "magnifying lass" from the optical department f a jewellery store. It is 1in in iameter, has a focal length of ap- roximately 3in, and is mounted in plastic frame with a 1-8in mount- g hole. It cost the modest sum f 3/- and was originally intended or reading small print.

With the aid of this lens we were ble to obtain consistent operation t any distance up to 25ft which, onsidering the small amount of light vailable, is rather remarkable. Since his is a greater distance than is kely to be needed normally it is robable that nothing more elabor- te will be required.

However, if greater distances are equired, it would be a simple mat- r to use a larger lamp, say a 25- att headlight lamp, operated from separate transformer.

Details of the lamphouse can be btained from the drawings and hotographs, though it is probable hat many readers will have some uitable container already available. wo adjustments should be provided or the lamp-holder, one to permit being rotated and the other to vary the distance between it and the lens.

Most lamps have their filament in a "V" shape and, by rotating the lamp, it is possible to locate the two sections of the "V" so that they merge into one line of sight. The distance from the lens is used to adjust the focus and should be variable from the focal length to about one inch greater than this distance. The focus is most critical for long throws, there being plenty of light to spare for short distances.

Where a distance of only two or three feet are involved it is advisable to throw the image slightly out of focus so that the light is spread evenly over the entire cathode surface, rather than being concentrated on a small spot. Small concentrated spots of light tend to cause undue wear on the cathode.

TYPE OF ALARM

There are two main methods of arranging the light beam. One is to place the lamp house and relay unit on opposite sides of the doorway and the other is to place them both on the same side and reflect the beam from the opposite side by means of a mirror. The latter arrangement means a longer throw but has the advantage of less wiring and, usually, a more convenient installation. With the unit and lamphouse described a distance of 12ft could be quite easily covered.

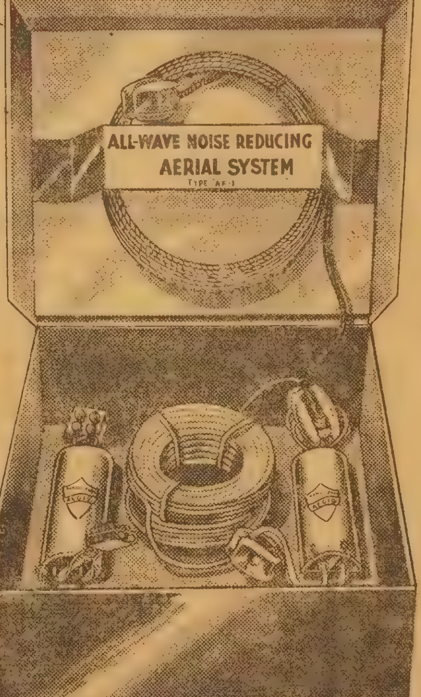
And, finally, a few words about the type of alarm which can be used in conjunction with this unit. Three possibilities suggest themselves: A bell, a buzzer, or a door chime, and the one finally selected will depend on individual requirements.

BELL TOO LOUD

A bell will make a lot of noise and is usually only necessary when the location is noisy or large areas are to be covered. In most cases it will be far too loud for a small workshop, and a buzzer is much less nerve wracking. Even these are unduly noisy at times and need to be operated at a minimum voltage.

One of the best arrangements would seem to be the door chime, since these would only operate when the beam was broken or restored. Thus, while quite positive in operation, they are far more pleasant to the ear and have the further advantage that a person who hesitates in the beam will not cause a prolonged sounding of the alarm.

There are many other applications for a unit of this type as well as variations in the manner in which it operates. We may have more to say about these in a later article.



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A SURVEY OF RADAR TECHNIQUES

PART 2 — HOW THE MAGNETRON WORKS

The previous issue discussed the functioning of the generalised radar set and enumerated the factors which determine its performance. The present article describes the magnetron transmitting tube which is almost universally used as the high power RF generator in modern radar practice. A simplified theory of its operation will be developed and some practical aspects of magnetron design and operation will be discussed.

THE magnetron tube is remarkably well suited to fulfilling the requirements of the pulsed radar system for short pulses of very intense r.f. energy at very high frequencies.

It is probable that no other electronic development contributed as substantially to making microwave radar possible and practical. As a consequence, the magnetron has emerged since 1940 from the status of a laboratory curiosity to a highly developed vacuum tube category having dozens of standardised types.

Pulsed power outputs range from a few watts to several million watts at frequencies extending from a few hundred megacycles to well over 30,000 megacycles. Operating efficiencies as high as 85 pc at 1200 megacycles have been reported by reliable observers.

The physical appearance of a typical magnetron tube is illustrated in Fig. 1.

A magnetron is a diode electron tube in which a strong magnetic field is used perpendicular to the direction of electron flow. It is capable of generating extremely high frequencies at good efficiency because the frequency-limiting effects of electron transit time, which limit convention negative-grid triodes to about 3000 megacycles, are reduced by the action of the magnetic field.

A further advantage is gained from the fact that the resonant circuits are usually contained within the vacuum envelope of the tube, thus reducing lead inductance.

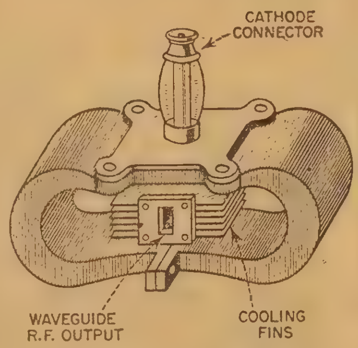
INTERNAL STRUCTURE

Fig. 2 shows the internal structure of a microwave magnetron. A cylindrical cathode is mounted in the centre of a solid copper anode bearing a number of resonant circuits machined in its inner surface. Each of these "cavities" is the equivalent of a parallel resonant circuit tuned to the desired magnetron operating frequency.

The evolution of such microwave resonant circuits from the conventional parallel L-C circuit is demonstrated in Fig. 3. An external circuit may be coupled to these resonators by an inductance loop as in the low-frequency case. The entire assembly is enclosed in a vacuum-tight metal envelope and evacuated.

A magnet which may or may not be an integral part of the magnetron, is used to apply a magnetic field in a direction parallel to the cathode.

In any oscillator or amplifier tube the electrons possess energy of motion, or kinetic energy, which was gained from the applied DC voltage. This kinetic energy is converted to useful radio frequency energy when these electrons travel against a retarding r.f. field so that their velocity is reduced.



TYPICAL RADAR MAGNETRON

FIG. 1

In a triode, RF energy is added to the "tank" circuit by electrons which flow between the grid and the plate while the latter is at the negative part of the RF cycle. Electrons which are not decelerated by the retarding RF field dissipate their kinetic energy in the form of heat upon striking the anode.

If all of the electrons could be slowed by the retarding RF field to zero velocity before reaching the anode, all of the energy gained from the DC field would be converted to RF energy, and the efficiency of the tube would be 100 pc. Such is fa from the actual case, however.

Triodes are severely limited at hig frequencies because, for maximu energy conversion, the electro must traverse the space between th grid and plate while the retardi field there is maximum. This di tates that the transit time should less than about one-tenth of the pe iod of one RF cycle for good eff ciency.

Electrons which are not so optim ally phased do not interact with strong retarding field and so a wasted. In going between the catho and the plate, the electrons in a trio have only one chance to interact wi the RF field.

In the magnetron, the mechanis of energy conversion is much mo perfect, however. Electrons may tak the period of many RF cycles to rea the anode and may interact with strong retarding field almost contin ously during this time.

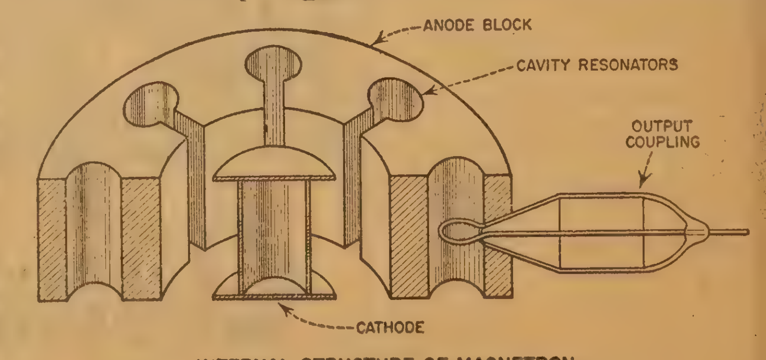
MAGNETIC FIELD

How this can occur is illustrated Figs. 4 and 5. In the absence of magnetic field, the electrons in magnetron would flow radially fro cathode to anode, as in any diod See Fig. 4a.

However, when a slight magnet field is applied parallel to the ax of the cathode, the paths of the electrons are bent, as in Fig. 4b.

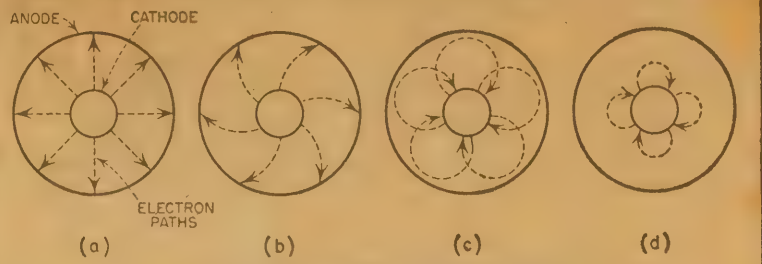
As the magnetic field strength increased, a critical value is reach at which electrons no longer rea the anode, but describe a loop, orbit, and return to the vicinity of t cathode. This is the condition call "cut-off," since no current reach the anode (Fig. 4c).

If the magnetic field is increas

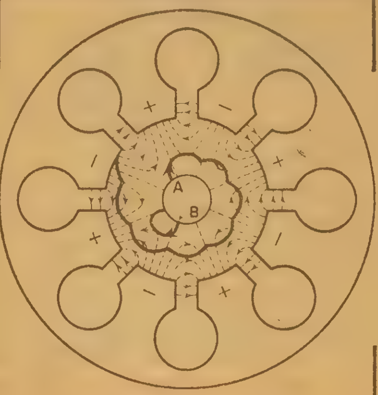


INTERNAL STRUCTURE OF MAGNETRON

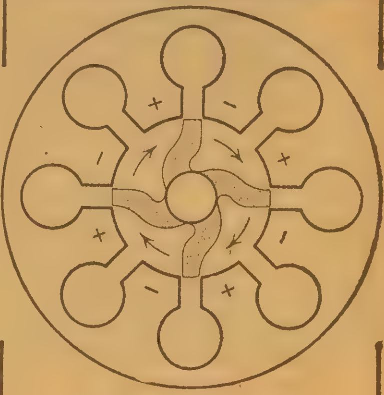
FIG. 2



ACTION OF MAGNETIC FIELD IN DIODE
(Field Perpendicular to Paper)
FIG.4



PATHS OF ELECTRONS IN MAGNETRON
FIG.5



ROTATING SPACE CHARGE IN MAGNETRON
FIG.6

urther, the electrons' orbits become ery small, as in Fig. 4d.

Theoretically, the electrons return the surface of the cathode with ero residual energy in a non-oscillating magnetron, such as we have een discussing. This is because the lectrons lose as much energy re- urning to the cathode against the C field, as was gained from it dur- g the outward travel.

The above considerations are true f a static, non-oscillating, magne- on. When RF oscillations, such as ight be started by noise voltages or ther transients, are present in the avity resonators, these conditions re greatly modified.

The RF voltages associated with ese oscillations produce fringing lectric fields in the interaction space etween the cathode and anode, hich extract energy from the whirl- g electrons in a truly remarkable anner.

LUX DISTRIBUTION

Fig. 5 shows the instantaneous dis- ibution of these fields within the agnetron interaction space. The rrows indicate the direction of the rce which the fields exert on an lectron. The electric fields vary inusoidally with time, so that one- alf cycle later the arrows are re- ersed.

It will be noticed that retarding elds exist across each alternate gap. n electron starting from point "A" avels against the RF field during s first orbit, and so delivers energy the resonant circuit.

Having delivered part of its kine- c energy, it no longer can return the cathode surface, but comes to est some distance from it. It is then -accelerated by the DC field and, nce the fringing RF field has re- ersed in the meantime, passes the ext resonator gap against the RF eld.

This process continues with the lectron progressing closer to the node with each orbit and convert- g part of its kinetic energy to RF nergy, each time it passes a gap. hus, an in-phase electron has many hances to deliver energy to the scillating circuit and reaches the node surface with little residual en- rgy to be converted into heat.

Conversely, consider an electron mitted at point "B" in Fig. 5. Here he fringing field is such as to accele- ate the electron. Since the RF field oes work on the electron, energy is ubtracted from the useful output of he tube and its efficiency is reduced.

However, such out-of-phase elec- rons are eliminated from the inter- ction space after only one orbit ince, in gaining energy from the scillating circuit, they have more an enough energy to reach the cath- de on the return trip.

ECONDARY EMISSION

The result is that these electrons ombard the cathode and dissipate eir residual energy as heat. This ives rise to two effects which are nique characteristics of magnetrons.

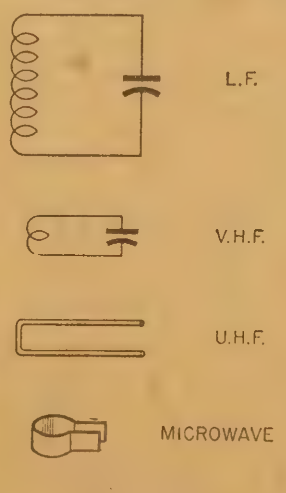
One effect is that the returning, or ack-bombarding, electrons dislodge ther electrons from the surface of e cathode. This secondary emission reatly enhances the current norm- lly available from the cathode, mak- g higher power possible.

The other effect is that the bombarding electrons sometimes dissipate enough heat at the surface of the cathode to permit the normal cathode heating power to be disconnected without interrupting operation. Thus, in the magnetron, even the otherwise wasted electrons are utilised to improve the overall efficiency of the tube.

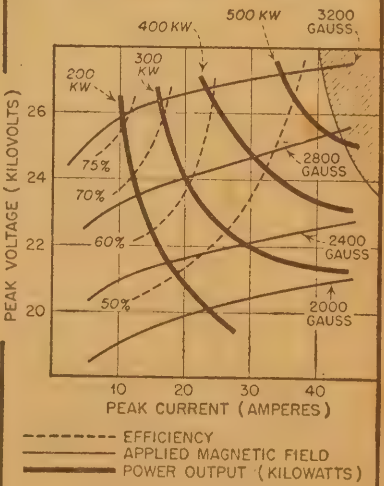
Of course, the above discussion assumes that the electrons which are delivering energy rotate around the cathode at a velocity which will keep them in step with the alternating r.f. field. This synchronous velocity is achieved by adjusting the operating voltage E for a given magnetic field B, since the rotational velocity of the electrons is equal to E/B.

Thus, the electrons in a magnetron which are phased so as to deliver

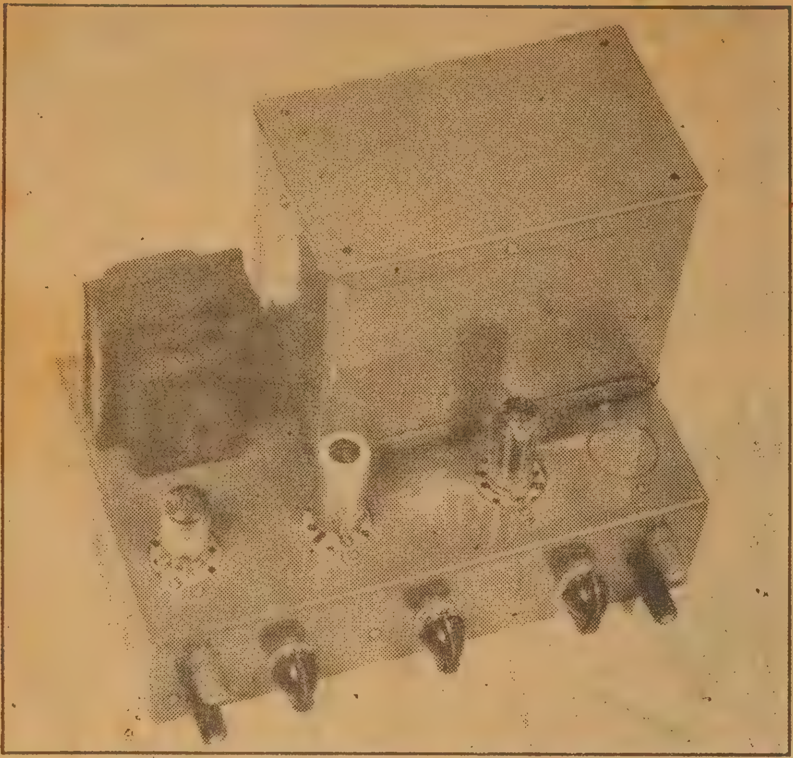
(Continued on Page 86)



EVOLUTION OF CAVITY RESONATOR
FIG.3



TYPICAL MAGNETRON PERFORMANCE PLOT
FIG.7



A front view of the amplifier showing the 6BR7 at the left, the 6UA6 (under shield) and the 6AQ5 output valve. Controls, left to right, are "Mic. Volume", "Pickup Volume" and "Tone". Mic. terminals are at the left, Pickup terminals at the right.

Here is number three in our current series of vibrator-powered amplifiers—this time one designed for use with both microphone and pickup. It is relatively simple in design and should meet the many requests through the mail for a small general purpose amplifier of this type.

VIBRATOR AMPLIFIER FOR P.A

THE two previous designs, you may remember, were firstly for a simple gramophone amplifier and secondly for a higher quality unit capable of wide-range reproduction in association with the "Playmaster" tuner and control heads.

This present design visualises yet another requirement—that of low power public address work using both pickup and microphone, with provision for independent fading and mixing.

At the outset, a few words of guidance may be in order about possible uses for this type of amplifier, which offers about 4 watts of audio power.

MODERATE POWER

In the normal realms of AC operated equipment, a 4-watt PA system would not be taken very seriously, because it can only make a limited amount of "noise" before running into the overload region. Since power and operating costs mean very little in AC equipment, designers play safe and seldom specify anything less than push-pull output valves and a power rating of 8-10 watts.

At the same time, properly used, a 4-watt amplifier can do a very useful job, saving battery drain into the bargain by reason of its more modest line-up of valves.

The secret of success with a small amplifier lies in making full use of the available audio power and avoiding all unnecessary losses.

To start with, make sure that the battery is in good condition, that the leads between the battery and the amplifier are no longer than necessary, and that all connections are electrically sound.

With 4 or 5 amps flowing in the primary circuit, a fraction of an ohm resistance can produce a drop of anything up to 1 volt. A loss of 1 volt in 6 represents a loss of 16 pc, which means something like 40 volts off the high tension. And away goes one-third of the power output!

The 6AQ5 requires just over 260 volts between screen supply and cathode for its rated power output and you should begin to ask questions if this figure is not realised.

Then again, it is desirable to use a good quality output transformer to ensure that most of the power reaches the secondary circuit. Cheap and nasty speaker transformers can exhibit an efficiency figure as low as 40 pc whereas a good transformer will run as high as 85-90 pc, representing a 2:1 difference in the available power at the speaker.

If you want to get the best out of the amplifier, make sure that the ou put transformer supplied with t speaker is of generous dimensions otherwise, invest in one of the co mercial "PA" types with a seconda impedance rating to suit.

The final point concerns the cho of a speaker. One of the expo ential PA type horns will make terrific din with four watts into t voice coil, but few enthusiasts w be able to afford one of these. Mo likely, you will have to use an o dinary permag speaker.

These vary a good deal in the ma ter of sensitivity, the things to lo for being modern design, a fai large cone and a high-flux magn In practice, most of the mode eight to 12-inch speakers will do good job.

Rather than rely on a flat baff it is a good scheme to provide so sort of a flare in the front of t cone to concentrate the sound in forward direction.

The throat of the flare should approximately equal in area to t cone, the flare itself being about 1 inches deep and enlarging to an ope ing at the front about 2-feet wide a 1-foot high. With a little ingenui quite a serviceable flare can be fas ioned from about 3-8in ply or ev ¼in ply suitably braced.

The back of the speaker can enclosed in a box about 12 x 12 10in (inside), preferably lined wi hair felt and provided with a few holes at the rear to relieve back pre sure on the cone.

DOUBLE FLARE

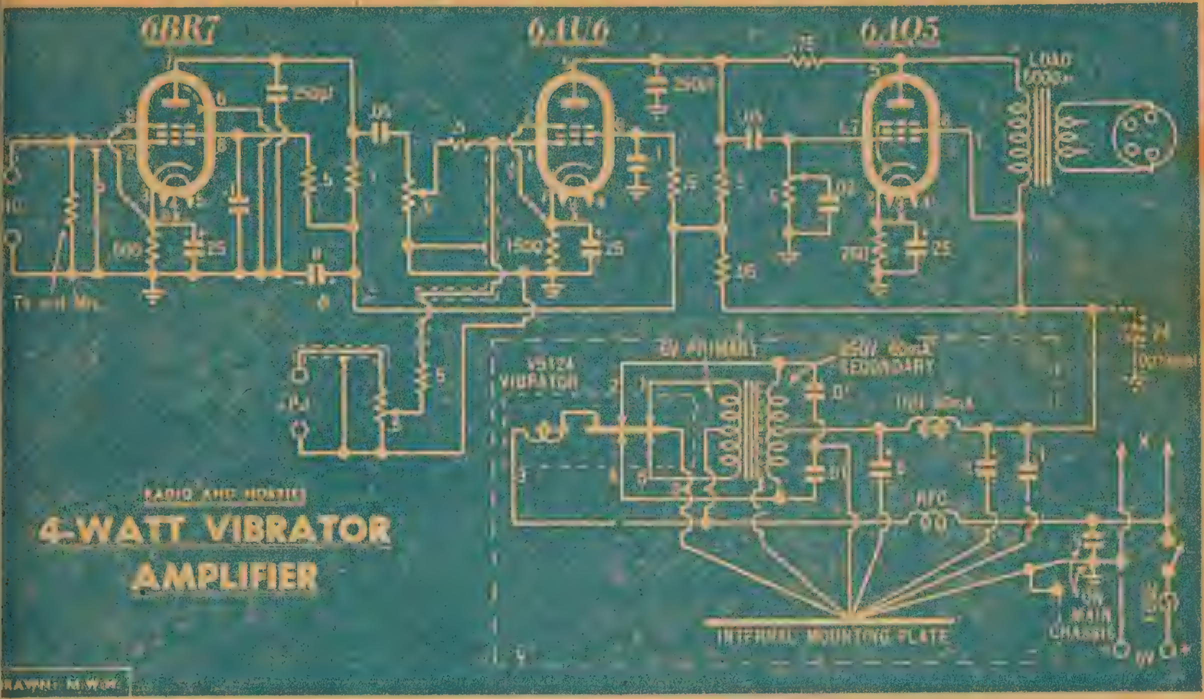
If you have any idea of operati mobile PA from a car, it is po sible to provide a flare both in fro and behind the speaker to utilise total output.

There is nothing very critical scientific about the design of box and flares of this type and it isn hard to get good results for PA wo provided:

(1) The flare is of generous dime sions and free from rattles, and

(2) The back of the speaker is n shut up in an excessively small airtight box.

CIRCUIT HAS PROVISION FOR MIC. AND PICKUP



The complete schematic circuit diagram. Note that components shown in the dotted border mount inside the vibrator box, which mounts in turn on the chassis. As in all vibrator sets, the polarity of the HT output is dependent on the connection to the battery and/or the wiring to the transformer. It may be a good idea to earth the positive battery pole if the amplifier is to be used frequently in a car.

Watch all these points and you ll find the amplifier entirely pracal for use in a moderate size hall, a car or anywhere out of doors ere traffic and other noise is not high.

or the most part, the circuit is ntical with the Basic Vibrator Amfier described in the April issue. fact, if you have any ideas of ilding this amplifier, it would be y wise to read through the preling articles to gain a complete ture of the problems involved.

he line from the battery passes ough a fuse and a switch, which can either ignore or instal to t your own ideas. Many construcs will not bother with either, simclipping the amplifier to the baty when it is required.

MPLE FILTERING

n the main chassis, the 6-volt d is bypassed with a 0.5 mfd conser, passing then to the heaters into the vibrator supply.

his supply is identical with that the original Basic Amplifier, havonly a minimum of RF filtering. e, however, that all components mounted on a metal plate inside box, with all earth returns comto one point, as indicated in the uit.

his return point is bonded to a le point on the box and thence n earth point in the main chassis. he four long mounting bolts ich pass through the chassis, the tom of the box and the vibrator embly plate should be insulated h bakelite spacing washers such t they do not provide an earth return path between the three surfaces.

These precautions are a good preliminary insurance against trouble later with vibrator hash.

If you follow this general procedure, without trying for "shortcuts", there should be no worry whatever with vibrator hash with either the pickup or the microphone in use.

You will note that a 24 mfd condenser is shown dotted between the main high tension line and chassis. This removes the last vestige of hum but is only likely to be necessary where the amplifier is used at any time for low-level listening in a quiet room.

Apart from a minor change in the value of the feedback resistor, most of the circuitry around the 6AU6 and the 6AQ5 is conventional and the

PARTS LIST

1 Chassis 9½in x 6in x 2½in.
1 Shield box 6in x 5in x 3½in.
1 Mounting plate 5¾in x 3¼in.
1 Vibrator transformer 6V to 250V at 60 mA.
1 Filter choke 15H at 60 mA.
1 V5124 vibrator.
1 6AQ5 valve.
1 6AU6 valve.
1 6BR7 valve.
3 7-pin miniature valve sockets, one with shield.
1 6-pin valve socket with mounting flange.
1 Miniature plug and socket.
4 Spring loaded terminals.
2 Battery clips.
1 Low tension switch.
1 Fuse holder.

CONDENSERS

3 25 mfd 40V electros.
1 24 mfd 525V electro.
3 8 mfd 525V electros. (2 with mounting feet.)
1 .5 mfd 200V paper.
3 .1 mfd 200V paper.
2 .05 mfd 400V paper.
1 .02 mfd 200V paper.
2 .01 mfd 600V paper.
3 250 pf mica.

RESISTORS

1 Mic. load rest. (2 meg.)
1 .75 meg 1 watt.
3 .5 meg potentiometers.
5 .5 meg 1 watt.
1 .1 meg 1 watt.
1 .05 meg 1 watt.
1 1500 ohm 1 watt.
1 500 ohm 1 watt.
1 250 ohm 1 watt or 3 watt preferred.

SUNDRIES

Hook-up wire, shielded wire, tinned copper wire, 18 B and S enam. wire, nuts and bolts (4 bolts, 2in long), tag strips, 3 knobs, rubber grommets, solder lugs, low tension cable (plastic flex), &c.

The RFC is wound with 18 B and S wire on ⅜ diam. to a length of 1½in.

Q-Plus Short Wave Coils

Unshielded High Performance High Frequency Aerial, RF and Oscillator Coils.

Size: O/all Height 2in (without core protruding). Above or below chassis 1¾in. O/all diameter ¾in.

Former Details: Moulded polystyrene grooved 16. t.p.i. 9/16in o/s diam.

Mounting: Single 3/16in hole

Tuning Capacity required for Nominated Frequency Coverage. 25—445 pf inc. strays

Wiring Code

	Aerial Coil	RF Coil	Osc. Coil
Blue Pin	aerial	plate	Osc. plate
Red Pin	earth	B+	B+
Black Pin	AVC	AVC	padder
Green Pin	grid	grid	osc. grid

Frequency Coverages Available		
	7.2—23 m/cs	SW13
	5.9—18 m/cs ..	SW16
	2.0— 6 m/cs	SW50

Padder Value Required 4000 pf 13 and 16 m. bands.
2000 pf 50 m. bands.

REMARKS

General purpose s.w. coil using lo-loss materials, polythene covered wire, high frequency carbonyl cores, etc., etc. Normal oscillator coil is designed to operate with Innoval or triode hexode convertors only—e.g. 6AN7, ECH35, 6AE8, X61M, etc.

Aerial coils are dotted with blue dot

RF with green dot and osc. coils with red.

In order to order, the prefix A=Aerial, R=RF, O=Osc. is used. Thus, SWA/13=13m aerial coil, SWO/50=50m osc. coil.

Q-Plus Car-Radio Coil and I.F. Kits

Type CRK1 Complete midget kit of coils plus IF's
CRK2 Midget kit without RF coil
CRK3 As for CRK1 but with higher gain standard size aerial coil

KIT DETAILS

CRK1 comprises:

1 IF1 IF transformer 455 KC
1 IF2 IF transformer 455 KC
1 AC2 Car radio aerial coil
1 RC2 Car radio RF coil
1 05 6BE6/6SA7 oscillator coil
1 IC1 Ignition filter coil

CRK2 As above, but less type RC2
CRK2A As for CRK3 but without RC2
CRK3 As for CRK1 but type AC7 aerial coil replaces type AC2.

See Respective Data Sheets For Individual Coil & IF Performances.

CIRCUIT RECOMMENDATIONS

The user is referred to April, 1953, and March, 1952, issues of Radio & Hobbies for full instructional details. Commercial Set Performance is easily obtainable when using these Kits.

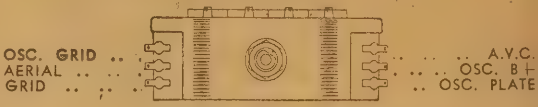
R. W. Steane & Co. Pty. Ltd., Auburn, Vic.

Page

Q-Plus D.W. Brackets

WIRING CODE, ALIGNMENT CODE AND FURTHER OPERATING DATA

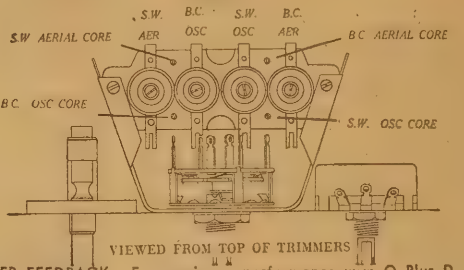
WIRING CODE


OSC. GRID
AERIAL
GRID
A.V.C.
OSC. B+
OSC. PLATE

SHAFT TOWARDS VIEWER

N.B.: When unit is type DW7, i.e. for tapped oscillator coil, the Osc. B+ pin is not used whilst the oscillator plate becomes the oscillator cathode connection.

TRIMMERS


S.W. AER
B.C. OSC
S.W. OSC
B.C. AER
S.W AERIAL CORE
B C AERIAL CORE
B C OSC CORE
S.W. OSC CORE

VIEWED FROM TOP OF TRIMMERS

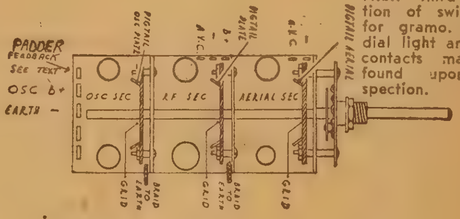
PADDER FEEDBACK. For maximum performance with Q Plus D. W. and D.W.R. Brackets Padder feedback is recommended on S.W. bands. This tends to improve stability over the band and lift sensitivity at the low frequency end. It is simple to incorporate and is accomplished merely by altering the position of the oscillator decoupling condenser from earth to the padder/coil junction—see alignment code below.

GRID STOPPERS AND OSC. GRID COUPLING CONDENSERS. Care should be taken to use the minimum value of oscillator grid coupling condenser — valves recommended are from 50pf-100 pf. It is sometimes necessary to compromise on the value for correct operation in both B/C and S/W bands. In the event that the size chosen for suitable low frequency or B/C band causes instability of the H.F. end, a small ½ watt resistor of about 30-40 ohms should be inserted in the oscillator grid circuit, between the valve grid and coupling condenser.

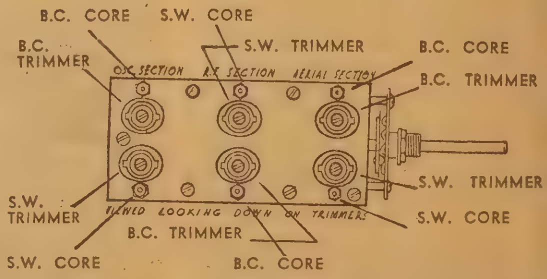
Q-Plus D.W.R. Brackets

PAGE 4

WIRING AND ALIGNMENT CODE


PADDER FEEDBACK SEE TEXT
OSC B+
EARTH −
PIGTAIL OSC PLATE
A.V.C. −
B+
PIGTAIL PLATE
A.V.C. −
PIGTAIL AERIAL
OSC SEC
RF SEC
AERIAL SEC
GRID
BRAID TO EARTH
GRID
BRAID TO EARTH
GRID

N.B.: Third position of switch is for gramo. Spare dial light and B+ contacts may be found upon inspection.

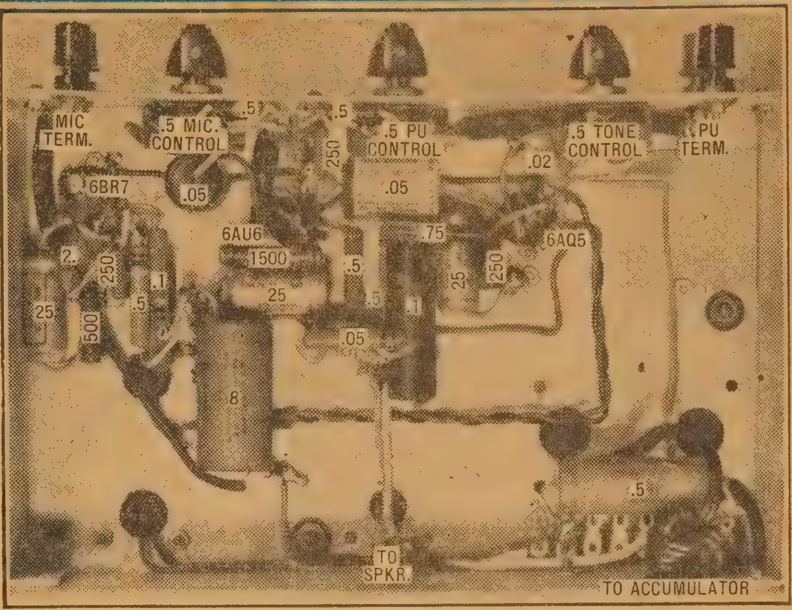

B.C. CORE
S.W. CORE
B.C. TRIMMER
S.W. TRIMMER
B.C. CORE
B.C. TRIMMER
OSC SECTION
R.F SECTION
AERIAL SECTION
S.W. TRIMMER
S.W. TRIMMER
VIEWED LOOKING DOWN ON TRIMMERS
S.W. CORE
B.C. TRIMMER
S.W. CORE
B.C. CORE

See Type DW for padder feedback and osc. grid coupling condenser recommendations.

NOTE

Every set and every Q-Plus DW or DWR bracket is actually set tested and sensitivity measurements taken.
Subject to change without notice.

UNDERNEATH AMPLIFIER, SUPPLY



There is plenty of room beneath the chassis for the various components. Note that all input earth returns for the 6BR7 are made to one point near the valve socket. Note also the wiring method for the two .05 meg. resistors in the mixing circuit.

ne as in the first amplifier. You ll note, however, that we have umed the use of an output transmer mounted on the chassis, for isons outlined earlier in the article.

You can please yourself on this nt, however. The use of feed- k between the plates, rather than m the voice coil winding, renders circuit non-critical as regards type and placement of the out- transformer.

What is new in the circuit is the ut end.

Tracing through the circuit, you l note that the microphone con- ts straight to the grid of a 6BR7 new low-noise preamplifier valve, used a pair of terminals here, you may prefer to spend a few ra shillings and instal a properlyelded microphone plug.

NGLE EARTH POINT

n wiring this stage, select a point ich is close to the valve socket the microphone connector and use as a common earth return point the grid and cathode wiring. By ng a single point earth return, you l avoid the chance of introducing sh into the input circuit due to ly currents in the chassis.

Once again, this method of wiring precautionary, but it may save rry when the amplifier is finally itched on.

Input terminals for the pickup are the opposite end of the chassis, gether with the pickup volume con- l.

Do not earth the circuit at this d of the chassis, however. The th return, as also for the braid, uld be brought to a point near 6AU6 socket, as indicated on the cuit. A piece of large-diameter ghetti tubing, slipped over the aid, will prevent it touching the assis at any other point.

The two 0.5 meg. resistors in the xing circuit are third-watt types unted directly between the centre on the respective pots. and a strip midway between the two. om the junction point, a short gth of shielded wire runs down to 6AU6 grid.

ATURAL SHIELDING

By shielding this lead and keep- the two resistors close to the assis wall, a fair degree of shield- is achieved. There is less chance picking up power supply "buzz" an if the two resistors were simply out in the open.

In operation, the two resistors are entially feed paths for the sigls between the respective volume ntrols and the 6AU6 grid. The retors prevent either control from orting the other and, in practice, ow the inputs to be mixed and led with very little audible inter- ion between the two.

For best average results, it is as- ned that a crystal pickup will be ed, the load and gain figures on pickup channel being selected th this in mind.

On the microphone channel, the in is ample for most types likely be used for PA work. Most ob- us choice would be a crystal type, th high output dynamics running close second.

In either case it will be necessary exercise care to avoid hum or sh pickup in the microphone cable and the latter will need to be shielded. For preference, low loss cable having a minimum capacitance per foot should be used in order to avoid shunting the output from the microphone.

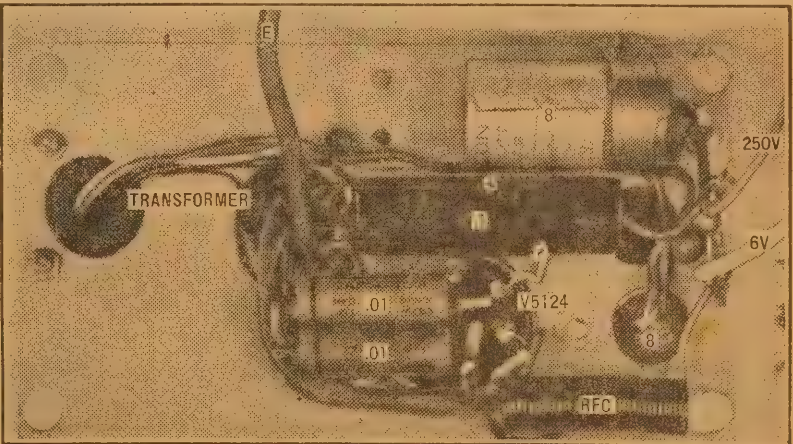
In the case of the crystal microphone the capacitance of the cable has the effect of reducing the overall output, rather than the high frequencies alone, due to the fact that the microphone is itself a capacitor of considerable value.

While this effect is less serious than with other types of microphones, where the high notes only are attenuated, it can still be a problem because it may well drop the output of the microphone to a point where the gain of the amplifier is inadequate. For this reason the dynamic microphone may be more satisfactory in some cases.

In the case of the dynamic microphone there are two possible methods of connection. One is to use the microphone as supplied with its transformer in the case and use a shielded cable to connect to the amplifier. This will cause loss of high notes if the cable capacitance is excessive.

The other method is to remove the transformer from the microphone case and mount it near, but not on, the main chassis. Connection between the microphone and the transformer may now be made with unshielded wire, such as plastic flex, though it may be necessary to earth one side of the line. The line from the transformer to the amplifier should be shielded and the transformer should be about three or four feet from the amplifier to avoid magnetic coupling with the vibrator transformer.

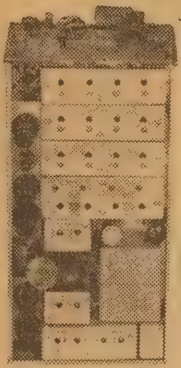
With this method there is virtually no loss in the cable between the microphone and the transformer.



A view underneath the vibrator assembly plate. This should be bonded at one point only to the shield box, this being bonded in turn to the chassis at a single point. For further details of this supply, see the April issue.

— COMMUNICATION — RECEIVERS —

R.C.A. TYPE A.R.B. RECEIVERS



Made in America.

CONTINUOUS COVERAGE 195KC TO 9050KC in 4 SWITCHED BANDS. Valve line up 12 F7 R.F., 12SA7 converter, two 12SF7 I.F. amplifiers, 12SF7 det. and 12A6 output.

£19/10/-

PLUS FREIGHT

Receiver complete with genemotor for 24V operation but readily adaptable for 12V or 32V. D.C. operation or 240V A.C. with external power supply. PHOTOSTAT OF CIRCUIT SUPPLIED WITH EACH RECEIVER

Converted to 240 volt A.C. operation with power supply and speaker.

£29/17/6 FREIGHT EXTRA

A.R.8 RECEIVERS

MADE BY A.W.A.

Eleven valve receiver using standard 6.3V octal valves. Con tinuous coverage 140 K.C. to 20 M.C. in 6 bands. Complete wit valves. CIRCUIT AND PLUG SUPPLIED WITH EACH RECEIVE

£18/17/6 PLUS FREIGHT

Converted to 240 volt A.C. operation with power supply an speaker.

£29/17/6 PLUS FREIGHT

A.T.5 TRANSMITTER

Covering 140 K.C. to 20 M.C. in two separate tuned circuits wi provision for crystals and V.F.O. Complete with valves. CIRCUIT AND PLUG SUPPLIED WITH EACH UNIT.

PLUS FREIGHT **£9/17/6**

Aerial coupling unit for above £2/-/-.

NEW H. F. RECEIVERS AND TRANSMITTER

COMPLETE WITH FOURTEEN 6.3V VALVES AND PLUGS, etc.

IDEAL FOR 144 MEG. BAND

NEW IN CARTON **£4/17/6** GENUINE BARGAIN

A.C. AMP METERS

A.C. Amp. Meters (ex-County Council). A necessity in any electrical workshop.

RANGE. 0-5 amps (can be extended by shunts).

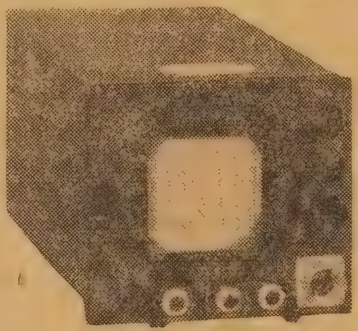
MOVEMENT. 300 degrees.

SCALE LENGTH. Nearly 15 inches.

DIAMETER. 7½ inches.

37/6

Plus postage.

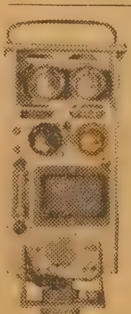


New American indicator units. Complete with 8 valves 5BP1 (with MU-metal shield) 4 6AC7 and 3 6H6 Ideal for that Oscilloscope.

£9/17/6

PLUS FREIGHT

New Lucas English Genemotors



Input 12V. Output 250V at 65Ma Supplied with input filter.

£2/10/- Postage NSW 6/6. Interstate 8/9.

FOUR VALVE AMPLIFIER

American amplifier complete with two 7C5, one 7C7 and one 7Y4 Valves in brocaded aluminium case. (No power supply.)

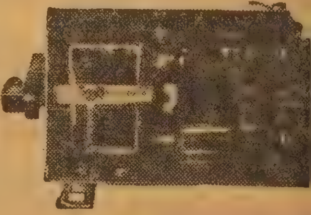
Postage NSW 4/-. **27/6** Interstate 8/6.

H.F. Oscillator

Frequency approx. 200 m/c. Adaptable to the 144 m/c Band. Complete with 2-7193 Valves.

Type "B" 12/6

POST FREE



METROPOLITAN

479 PARRAMATTA RD.
(AT TOP OF TAVERNERS HILL)

NEW — SPEAKERS — AT — HALF — PRICE

Special purchase of 1000 new Permagnetic speakers made by one of Australia's leading manufacturers enables us to sell these units at half price.

8in SPEAKERS

IEAVY-DUTY PERMAGNETIC WITH
0,000 OHM C.T. TRANSFORMER .. **34/-**

6in SPEAKERS

HEAVY-DUTY PERMAGNETIC WITH
15,000 OHM TRANSFORMER **29/-**

POSTAGE and PACKING

	NSW	Interstate
12in SPEAKERS	7/6	12/6
8in SPEAKERS	5/6	9/6
6in SPEAKERS	5/-	8/6
TRANSFORMERS	1/6	

12in SPEAKERS

HEAVY-DUTY PERMAGNETIC WITH 5000 OR 10,000 C.T. TRANSFORMER **54/-**

WITH 15,000 OR 20,000 TRANSFORMER 50/-

Separate Transformers to suit any of above speakers—5000 or 7000 ohm 8/6 each. (Supplied with speakers only).

— NEW — RECORD — CHANGER — CLEARANCE —

WORLD-FAMOUS ENGLISH H.M.V. CHANGERS. Fitted with high fidelity lightweight pick-up and matching transformer plays 9in, 10in or 12in records. Finished in Brown brocade.
Freight extra.

£8/15/-

"PAILLARD" CHANGERS. Made in Switzerland these changers are fitted with a variable speed motor, and high fidelity crystal pick-up with sapphire needle. Plays 8in, 10in or 12in records.
Freight extra.

£8/15/-

NEW VALVES IN CARTONS

SPECIALS

AV11	9/9
1K7G	8/6
1M5G	8/6
6K7G	8/6
6X5GT	7/6
VR65A	3/6

Special price for quantity.

This valve is the English equivalent of the EF50 with 4v fil, and English octal base. Please add postage on valves.

3S4	15/-
6C4	15/-
6AG5	15/-
EL33	12/6
IS5	15/-
IT4	15/-
IP5	12/6
IQ5GT	12/6
5Z3	15/-
IK5	7/6
6K8	12/6
6SH7	7/6
EA50	7/6
7193	5/-
EF50 with socket	11/6
6SH7 OR IK5 ..	5/-

In dozen lots.

NEW VALVE SOCKETS

Teletron 8 pin octal moulded sockets **5/-** per dozen or **25/-** per 100.

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Postage extra.

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English B.S.R. 4 pole synchronous motors 240V or 110V A.C. Ideal for that tape recorder.

£3/17/6 Plus Postage.

NEW ELECTROLYTIC CONDENSERS

8 MFD-525v **3/6** each or **34/-** dozen plus post.
8 MFD-350v **2/6** each or **24/-** dozen plus post.
16 MFD-350v **3/-** each or **30/-** plus postage.

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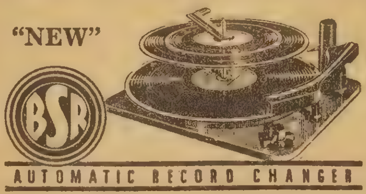

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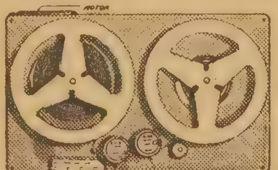

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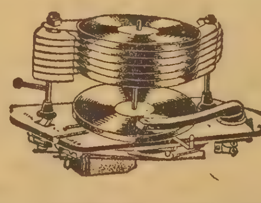

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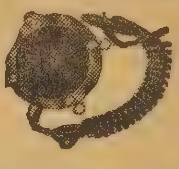

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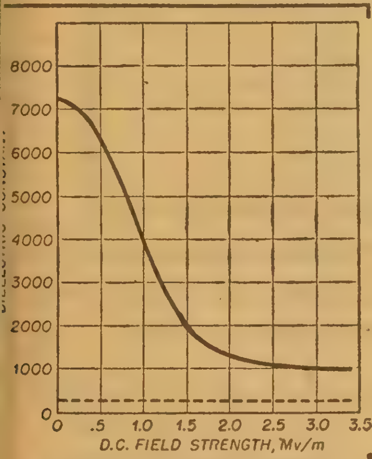
NEW TYPE CAPACITOR CAN AMPLIFY

You may know a good deal about valve amplifiers, and even the use of transistors for the purpose. Do you know, however, that special types of capacitor can be used as the basis of an amplifying circuit? This paper by Aerovox Engineers explains the principles of the dielectric amplifier.

'HE intensive use of complicated electronic devices having hun'eds of circuits, such as computers, uided missiles, radar, electric musil instruments, and others, has lded impetus to the search for subitutes for the conventional vacuum ibe.

In applications where extreme reability of operation, low heat dispation and freedom from microionic effects are needed, the fragile acuum tube leaves much to be dered.

The electronics design engineer as long dreamed of a rugged, pracally indestructible gadget of small limensions capable of efficient and fool-proof" operation to fill such ritical sockets.



EXAMPLE OF NON-LINEAR DIELECTRIC CHARACTERISTIC
FIG. 2

Attempts to realise this longought ideal have resulted in the inention and development of the ransistor, the magnetic amplifier and he dielectric amplifier. All of these pproaches hold great promise oi lleviating the "tube problem" in ertain fields and are of interest to vorkers in electronics.

This article is devoted to a pracical discussion of the characteristics f the last-named device.

The dielectric amplifier finds its najor field of use as a dc or lowrequency ac amplifier in "work iorse" circuits, where special characeristics of vacuum tubes are not ieeded.

Its upper frequency limit appears o be in the vicinity of 10 megacycles t the present stage of development, lthough time may prove that apreciable extension is possible, as vas the case with the vacuum tube.

Having the same basic structure s a capacitor, it has none of the ragility of a tube and is much heaper to construct.

Requiring no vacuum and having no filament or heater, it is much more reliable—an important consideration in today's electronic warfare, where the failure of a single 6AK5 can cause a ten-thousand dollar bomber mission to "abort."

And, because of the extreme simplicity of its construction, the dielectric amplifier should be easy to mass produce with uniform characteristics—a difficult accomplishment with vacuum tubes.

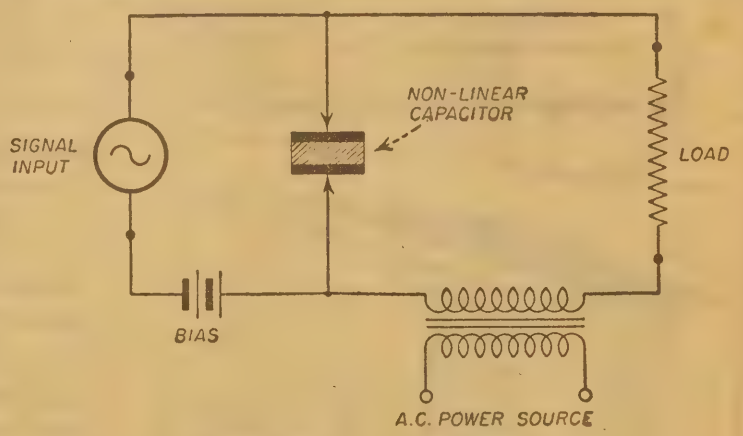
Figure 1 shows the basic circuit of the dielectric amplifier. It consists of a special capacitor connected in such a manner that the application of a small signal voltage to the "input," or "control," circuit causes a variation in the capacitance of the unit and hence a change in the alternating current flowing in the "output," or "load," circuit.

The power variation in the output circuit may be many times greater than the power change in the input circuit,, which produced it. Hence the device is a practical amplifier.

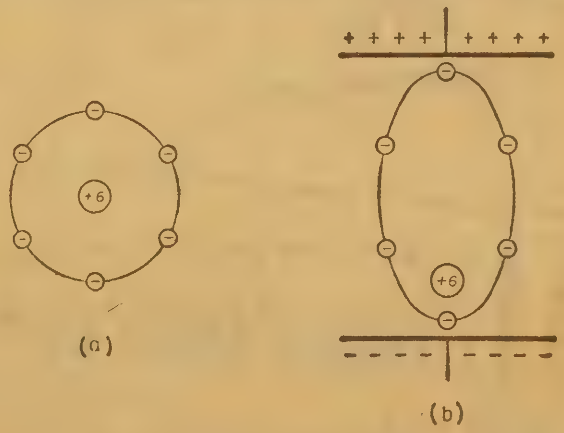
The capacitor used in dielectric amplifiers must have what is known as a nin-linear capacitance characteristic, ie, the dielectric constant and therefore the capacity, changes with the value of applied voltage.

This non-linear property is exhibited by capacitors which are constructed with polycrystalline dielectric materials which show ferroelectric effects.

Ceramics which have been used most extensively to date include

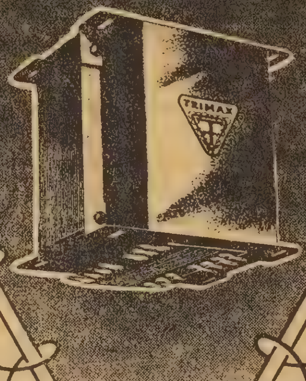


BASIC DIELECTRIC AMPLIFIER
FIG. 1



DISTORTION OF DIELECTRIC ATOM BY ELECTRIC FIELD
FIG. 3

TRIMAX *Quality*



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ium titanate, strontium titanate, ium zirconate, lead zirconate, and ious combinations of these. (It is eresting to note that barium and ontium carbonates are the ma- ials most commonly used to coat cathodes of vacuum tubes.)

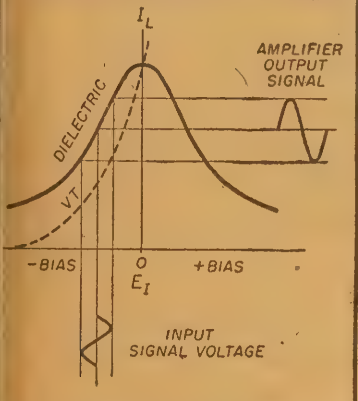
The study of dielectrics of this type relatively new and it is probable t further research in ceramics l yield more useful varieties.

The dielectric "constant" versus plied electric field strength of a pical non-linear dielectric is plot- in Fig. 2. The characteristic for standard "linear" capacitor is own in dotted lines for comparison. anges in dielectric constant ex- ding 10:1 have been observed in actice. Initial constants for typical n-linear dielectrics in common use ge from 1000 to about 9000.

To gain a working knowledge of operating principles underlying dielectric amplifier, a review of fundamental properties of di- ctric materials is profitable.

It will be recalled that a dielectric an insulating body in which elec- onic conduction is essentially im- ssible, because of the fact that all ctrons are firmly bound to their omic nuclei, so that very few free lence electrons are available for rrent conduction.

Thus, when the atoms of a dielec- c material are "at rest," the struc- ure of the individual atoms can be isualised as in Fig. 3a, which re- resents a positive nucleus surround- l by a symmetrical system of elec- ons held captive by the positive arge of the nucleus.

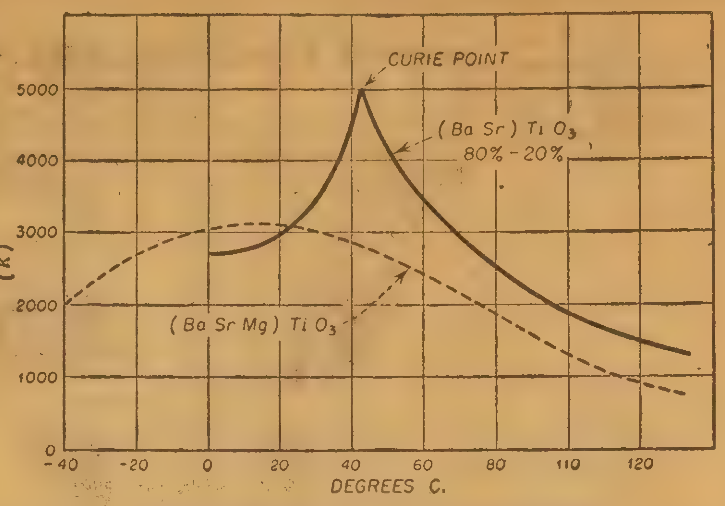


COMPARISON OF DIELECTRIC AND VACUUM TUBE AMPLIFIER CURVES
FIG. 6

However, if an electric field is im- essed upon a hypothetical dielec- ic made up of such atoms, the sys- m is distorted by the forces set up the field, so that it is no longer mmetrical, as illustrated in Fig. 3b. this condition, the atom is called induced dipole, and the dielec- ic is said to be polarised.

If the impressed electrostatic field removed, the atoms revert to the mmetrical condition.

The result of the polarisation of a ielectric material is that surface arges are set up on the surfaces the dielectric adjacent to the arged electrodes which apply the larising field. These surface arges act to reduce the electric field ithin the dielectric, compared to what it would be if the dielectric were not present.



TEMPERATURE CHARACTERISTICS OF TITANATES
FIG. 4

In other words, the permitivity of the space between the electrodes is decreased.

The reduction of the internal field depends upon the amount of distortion of the atomic structure; the degree to which the dielectric can be polarised. This is found to be essentially constant for any given type of conventional dielectric material, and is for this reason termed the "dielectric constant."

Materials with low constants undergo only slight deformation of the atoms, while those with high dielectric constant (K) experience greater distortion.

VARIES WITH FIELD

The non-linear dielectrics differ from the more common types principally in that the amount of distortion, or polarisation, is not constant, but varies with the impressed electric field. Therefore, the dielectric constant is not "constant." With it, of course, the capacity and reactance of the condenser change also.

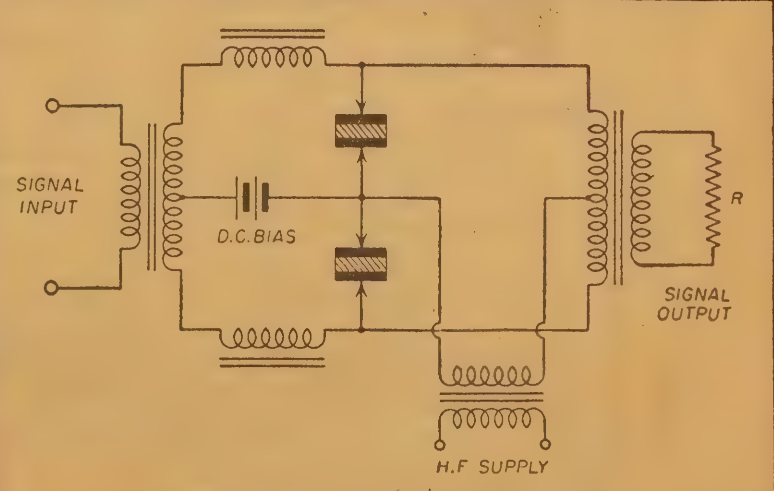
The other unique characteristic of these special dielectric materials is their extremely high dielectric constants, as mentioned above. This means that great distortion of the molecular structure is taking place. (Metals are sometimes considered dielectrics of infinite dielectric constant since extreme distortion of the atoms—including the complete removal of valence electrons—takes place, and the internal fields fall to zero.)

One difficulty that is encountered with the presently available grades of non-linear dielectrics is the dependence of the dielectric properties upon temperature.

This is illustrated in Fig. 4, which is the curve of dielectric constant versus temperature for a barium-strontium titanate body of 80 pc—20 pc consistency, respectively. The temperature at which the dielectric constant peaks is known as the "Curie point." Different ceramic mixtures have widely differing Curie points.

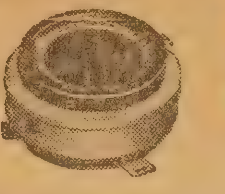
Dielectric amplifiers are usually operated on the negative slope near the peak. Changes in the temperature of the material can cause gain instability unless special measures, such as temperature regulation or compensation are applied. Here, again, further research is expected to unearth improved materials having less temperature dependence.

The dotted curve of Fig. 4 represents one example of this. By combining magnesium titanate with the usual barium-strontium titanate mix-



PUSH-PULL DIELECTRIC AMPLIFIER
FIG. 5

NAVIGATIONAL COMPASSES



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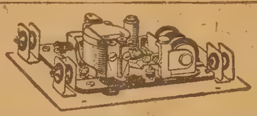

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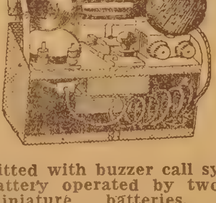

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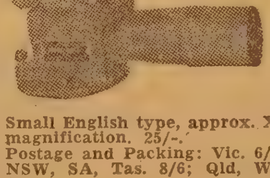

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practical circuit for a dielec- amplifier is given in Fig. 5. Here non-linear capacitors are em- ed in a push-pull arrangement. sformer input and output match- s used for impedance considera- and for added voltage gain.

ST BE AC

high-frequency alternating cur- power supply must be used in "plate" circuit of any dielectric lifier, since a change in the re- nce of the control capacitor can have an effect on alternating ent. A self-rectifying radio-fre- ncy power oscillator is common- tilised for this power source.

ne chokes shown in Fig. 5 are he purpose of isolating the signal t circuit from the AC power in output circuit. The DC bias es to place the operating point suitable part of the characteris- urve of the particular dielectric l.

typical curve of input voltage us output current for a barium nate condenser is shown in Fig. Note that this curve bears a re- blance to the Eg-Ip characteris- of the conventional vacuum amplifier (dotted line, Fig. 6) n the exception that it is sym- rical about the zero bias axis.

his symmetry of the transfer char- ristic is due to the fact that the tance of the non-linear capaci- is increased by either a positive- ng or negative-going signal at zero . In other words, an electric field either polarity causes the dielec- constant to vary. The vacuum characteristic normally has only ositive slope.

CUT-OFF

nother point of difference is t complete cut-off of output cur- t does not occur in the dielectric plifier as in vacuum tube devices s follows since the dielectric con- nt never becomes zero, as in in- ated by the plateau on the right- nd side of the curve of dielectric stant versus applied electric field wn in Fig. 2.

Dielectric amplifiers are usually sed for operation on the most ear portion of the positive slope, in conventional Class "A" opera- n, although other manners of eration are possible. If operated zero bias, the dielectric amplifier s as a frequency doubler.

---

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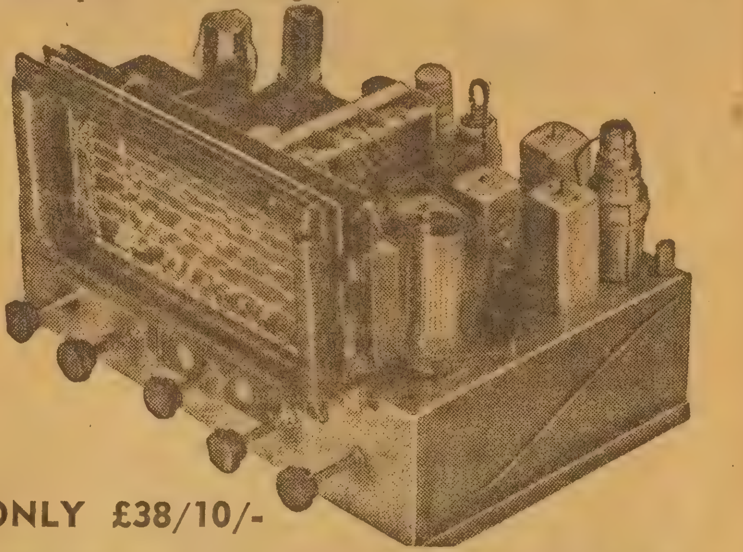

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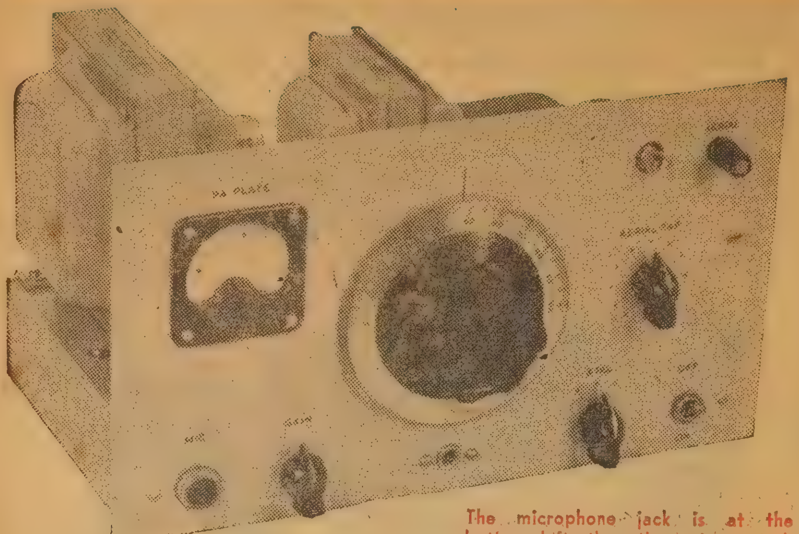


The microphone jack is at the bottom left, then the gain control, the key jack, the crystal switch and the on/off switch to the right. The aerial tap selector is to the right of the large tuning knob. The chassis used for the prototype was made from 18 gauge metal and measures 11in x 7in x 1¾in. The panel is 12in x 6¾in and is made from 16 gauge metal. Either mild steel or aluminium is suitable.

A COMPACT TWO-BAND XMITTE

Simplicity is the keynote of this fine little transmitter. Two bands, only one tuning dial, and n critical aerials required! Just the thing for an extra, low-powered phone station, or a beginne who is looking for a sure-fire, easy-to-make design. It will work perfectly with many differen types of valves, and has already chalked up some fine contacts, despite its low power.

by Maurice Findlay

OVER the years there have appeared at various times designs for small transmitters intended to be ultra simple or ultra compact. One-valve transmitters designed to fit inside a coffee can have become somewhat of a speciality with some of the overseas magazines.

That's probably quite all right from a novelty point of view. We grant that there is quite a kick to be had in making a contact with a transmitter no bigger than your hand, even if the chap the other end be only a few miles away.

But when you come to analyse it you will find that most of these small novelty transmitters make no provision for phone and have no inbuilt power supply.

PHONE AND CW

There are still plenty of CW adherents and plenty of cases when they can justify their loyalties, but it must be admitted that many amateurs wish to use phone for "rag chewing" on the 3.5 and 7.0 Mc bands. Therefore a simple transmitter must include a modulator.

A transmitter can be made to seem very small by omitting the power supply, but often the overall size of the transmitter is by no means small when all the necessary extras are included.

This new transmitter makes no claim to be the smallest transmitter ever built, or the cheapest or the easiest to build.

But it is a logical answer to a requirement that a large number of amateurs are likely to put forward.

Take the case of the amateur who has just passed his proficiency examination. It is unlikely that he will have large stocks of high-powered transmitting components. Cheap disposals goods are no longer available as freely as they were a few years ago and it is probable that he will have to buy a good many of the components that go into his transmitter through the normal channels and pay the normal prices.

Naturally he would like to be able to operate on all bands, but this cannot be achieved without a fa involved design. The "Five Transmitter" described in Radio Hobbies last year is an indicatio the sort of thing that is requirec

On the other hand the 3.5 anc Mc bands are excellent for local interstate communication and, as shall see, an excellent transmitte cover both bands can be made simply.

Then there is the matter of aer Plenty of amateurs are so situ that it is difficult to put up an c mum aerial for any one of amateur bands. A transmitter can feed an ordintry inverted L ae is a distinct advantage in such ca

Then again, there are some a teurs who have specialised eq ment, rotary beams, 100 watt tra mitters, &c., for 14 Mc and the bands but who feel the need c small transmitter to keep in to with happenings on 3.5 and 7.0

The transmitter described her intended to be as flexible as poss in the choice of components w fulfilling the requirements we h just outlined.

The radio frequency section of transmitter consists of a Pierce os lator feeding a beam tetrode a class C amplifier.

The Pierce type of oscillator is logical choice in a case like this, cause it obviates the need for a tun control and also the need for neutr ising the power amplifier. Practica any crystal can be plugged in will oscillate without any adjustm whatsoever.

THE AERIAL CIRCUIT

The power stage is a conventio class C amplifier, capacity couplec the crystal oscillator and plate screen modulated.

Of special interest is the arran ment in the output circuit. The quirements are, first, that it reson at the frequency at which outpu required and, secondly, that it vide some means of matching aerial to the output valve.

Where a resonant aerial is assur the problem is simple. If the ae is a doublet, fed with a length low impedance transmission line couple of turns wrapped around tank coil is an excellent means transferring the energy. Any nec sary adjustment of loading can made, either by varying the num of turns on link coil or by alter the relationship between the coils.

In the case of an aerial using tu feeders some special aerial tun device is the normal requirem We discussed the problem at sc ngth in the July and August, 1952, sues and these articles are an excel- nt reference on the subject for those ho do not wish to tackle lengthy xtbooks on aerial design.

As we said earlier, it is possible make practically any length of ire into a transmitting aerial. The ficiency of some odd length of wire not likely to be as great as a ecialised job, but there are often ses justifying its use.

If the aerial is not in itself resonant e circuits at the transmitter must ectrically subtract or add to the ngth of aerial until a resonant ngth is obtained. Otherwise the wer drawn from the transmitter y the aerial and hence the power diated will be very small.

OUPLING DEVICES

Over many years a favorite means resonating random lengths of wire as been by means of a "pi" section oupler. Essentially, it is a tuned rcuit the capacitive element of hich is split into two sections in ries with one another. The in- uctive element is a conventional il designed to resonate at the re- uired frequency with the optimum mount of capacity.

The aerial is connected to the junc- on of the two condensers and by arying the ratio of the two capacities is possible to match the impedance f practically any aerial. Unwanted apacitive or inductive reactance can e tuned out with this system which, properly applied, is a very flexible ne.

In our particular case the snag is hat to match very low impedance erials one of the condensers would ave to be prohibitively large. Using pi-section coupler we would prob- bly end up with a coil, a two gang ondenser with both sections in arallel and a single gang condenser f the type used in broadcast re- eivers. The arrangement would not nly be bulky but also more ex- ensive.

IMPLER METHOD

With the minor disadvantage that continuously variable control is ot available, much the same results an be achieved more conveniently y tapping the coil rather than the apacitive element. The appropriate ap can be selected by means of a multi-position switch.

In practice, then, the loading of he transmitter is adjusted by select- ng the appropriate tap, while the cir- uit, including the aerial, is brought o resonance by means of the tuning ondenser. Any inductive or capacitive elements in the aerial will have an effect on the setting of the tuning condenser required to reach esonance.

Tests with the device in operation rove that the scheme is quite practical. Actually there is nothing new about it. We can quote the type numbers of up to a dozen military adio sets with pi networks or tapped oil devices so that the transmitter ould be coupled to a random length f wire. They were operated successfully with pieces of wire strung ver trees in some cases, while in ther cases from a whip aerial attached to a moving vehicle.

So much for a general discussion of he RF and aerial requirements.

The audio section of a modern amateur transmitter must enable the radio frequency output to be modulated with good quality audio. The service equipment just mentioned in many cases employed a carbon microphone and a grid modulation system in order to simplify the modulator. Under laboratory conditions, where everything is perfectly adjusted, such a modulator can be made to sound quite well.

However, in practice it is difficult to adjust the loading and drive of the power amplifier to optimum conditions and keep it adjusted with variations in frequency, &c. A far more satisfactory scheme is to plate and screen modulate the power amplifier, a system which is much less critical in its adjustment.

With a crystal microphone a fair amount of gain is necessary in order to achieve full modulation, but with modern valves two stages can be made to do the job.

Small plate modulated transmitters frequently use a common iron-cored choke to supply high tension to the radio frequency and audio frequency power amplifiers and thus achieve modulation. This saves the expense of a special modulation transformer but has the disadvantage that there is a heavy direct current flowing in the winding, tending to saturate the iron core magnetically.

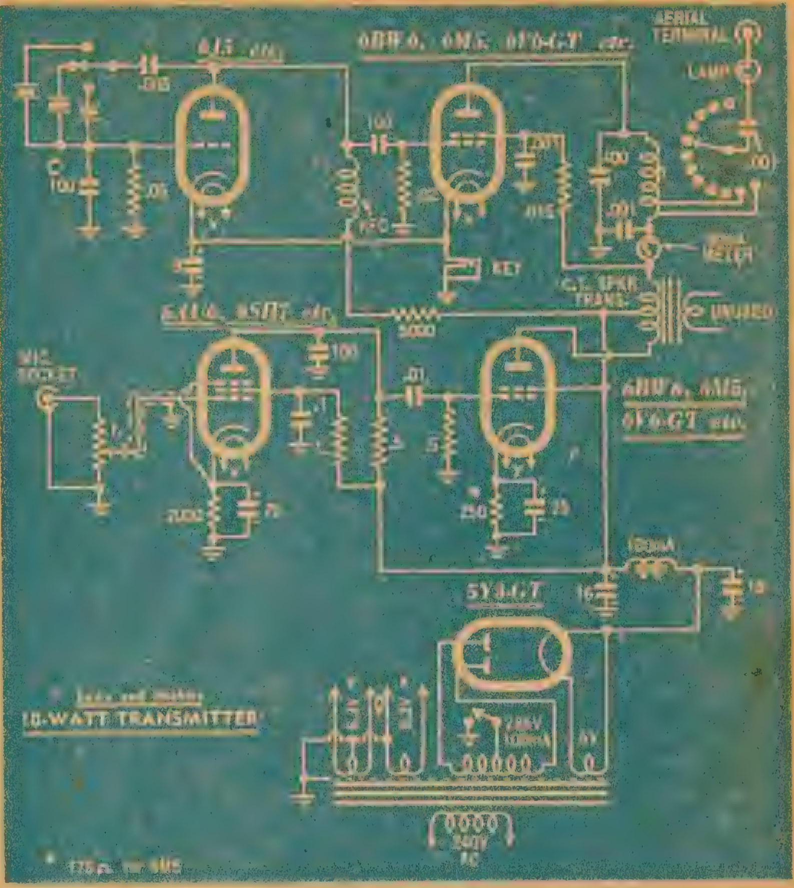
MODULATION CHOKE

This can be avoided by using a centre-tapped choke, feeding the high tension to the centre tap and connecting the audio and radio frequency power amplifiers to opposite ends of the choke. An ordinary centre-tapped speaker transformer does an excellent job at the power level being considered here.

As the single-ended audio power amplifier stage must be operated in class A to avoid distortion the drain on the power supply is constant during modulation. Therefore, no special effort need be made to obtain good regulation.

For full modulation the class C amplifier requires audio power equal

CIRCUIT IS VERY FLEXIBLE



Not the least attractive feature of the circuit is that it permits the use of a large variety of valve types. The arrangement used to obtain modulation is most unlikely to produce splatter.

THE OUTPUT COIL

The output coil consists of 24 turns of 18 B & S wire wound on a 1¼in diameter former. It is tapped at 1, 2, 3, 4, 6, 8, 10, 12, 15, 18, and 21 turns. Overall length is 1¾in. Either polystyrene or bakelised paper tubing may be used for the former.

If a lathe is available is is easiest to wind the coil in a shallow groove cut at 14 turns per inch.

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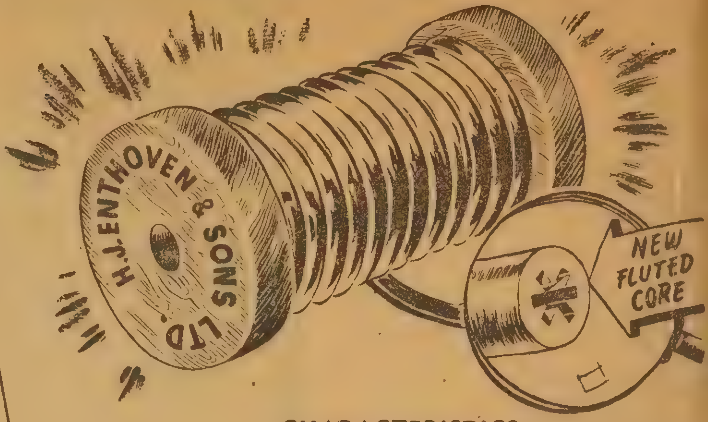

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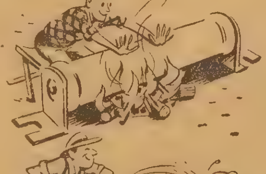

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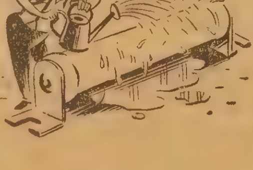

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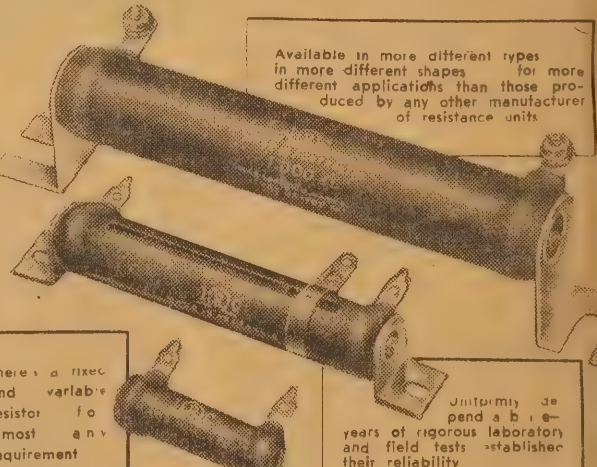

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o half the input. Therefore the mount that the class C amplifier is oaded depends on the audio power vailable. The pentodes and tetrodes nentioned deliver something between our and five watts, so that the input hould be adjusted to something between eight and 10 watts.

Approximately 260 volts high tension is available with the components pecified in the circuit so that the oading should be adjusted to about 5 mA.

A power input of 10 watts may not ound much on paper, but you can ake it from us that it does sound ealthy on the air, even over intertate paths.

THE CIRCUIT

Now for a more detailed analysis of the schematic circuit.

Sufficient drive for the power amplifier valve can be obtained from a small triode. Types 6J5, 6C5, 6J7, 6SJ7 and 6SH7, are suitable. The last three are pentodes, but may be connected as triodes by tying the suppressor to cathode and the screen to the plate.

The 6SH7 appeared to give a little less output than the others when tried in the original transmitter, but, as there is a reserve, this is no real disadvantage in practice.

In the miniature series, type 6C4 is an excellent choice

A resistor was wired in series with the plate supply of the crystal oscillator in order that the grid current of the power amplifier be between about 2.5 and 4.0 mA. With average crystals optimum grid current will be obtained with 5000 ohms. If you find that some adjustment of the grid current is required you can vary the resistor accordingly.

The constants of the crystal oscillator circuit have been chosen so that the crystal current is between 40 and 60 mA. This is unlikely to fracture any crystals you will wish to use.

WIRING IMPORTANT

In the interests of efficiency, it was found desirable to run short and direct leads for all the connections associated with the crystal and switching circuit. A poor layout of the wiring here may make it necessary to use a lower value of plate dropping resistor in order to get sufficient drive.

The radio frequency choke has some bearing on the efficiency of the stage. It is worth noting that there are RF chokes on the market which are quite unsuitable for the job. An inductance of about 2.5 mH, together with a low distributed capacitance, is required.

The crystal oscillator is coupled to the power amplifier via a 100 pf condenser. Bias for the latter is obtained automatically from the rectified grid current, which flows in the grid return resistor.

Correct operation of the output stage as a class C amplifier depends to a large extent on the grid current. If it is too small the valve will not be able to deliver the full output on the peaks of modulation, while, if it is too great, the screen current will tend to be excessive. As the screen has a series dropping resistor in this case, the voltage will drop and thus the output of the stage will go down.

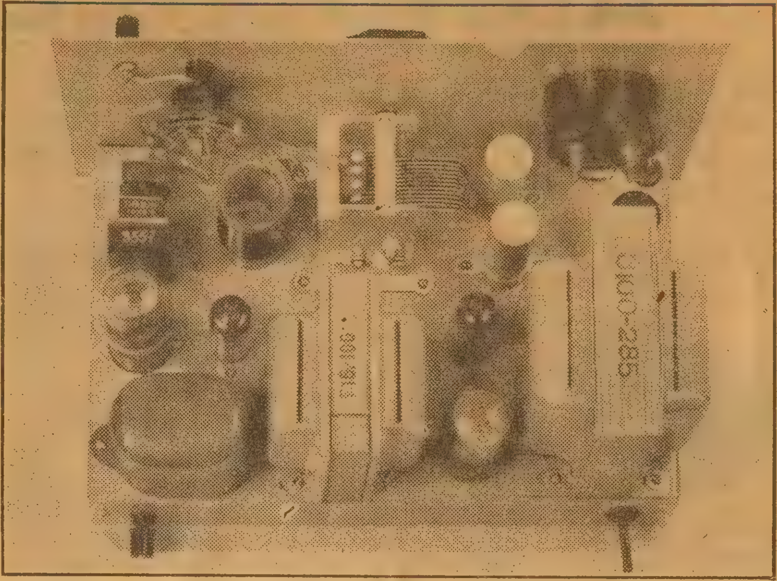
It was found unnecessary to provide protective cathode bias for the power amplifier valve, as the series screen resistor limits the plate current to a reasonable value when the tank circuit is detuned. Naturally, it is not a good idea to leave the transmitter on and mistuned for extended periods.

Any one of the valves mentioned on the circuit diagram is suitable for the power amplifier. No changes to the values as shown are required. Although the manufacturers do not recommend the 6M5 for RF applications, we have found that it works excellently.

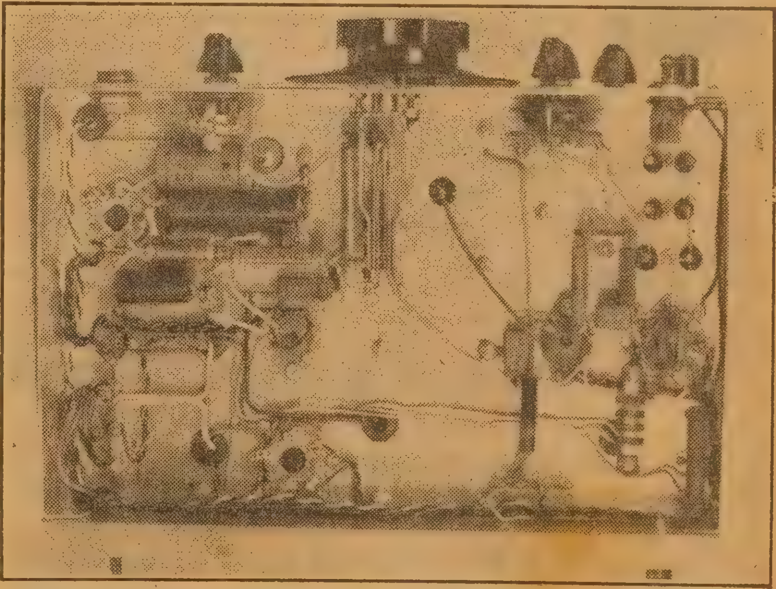
Don't run away with the idea that the grid drive is extremely critical. If it is kept within the limits quoted, everything will be in order. It is a good idea to install a meter temporarily and check the grid current, with all the crystals you are likely to use when first you get the transmitter operating, but thereafter you needn't worry about it.

A meter is installed in the plate circuit of the output stage in order to give an indication of that the tank

TOP VIEW OF THE TRANSMITTER



All components above the chassis are visible in this photograph. Major components along the rear of the chassis from left to right are modulation choke, filter choke, rectifier valve and power transformer.



Most of the underneath components are in the modulator at the top left. The transmitter section at the right is extremely simple. Note the key jack and electrolytic at the top centre.

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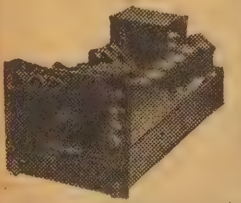

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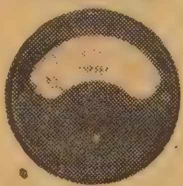

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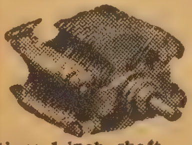

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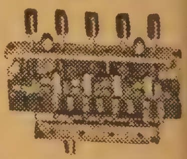

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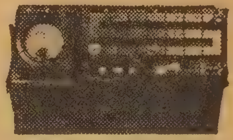

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circuit is tuned to resonance and also o indicate the loading.

Although it is not essential, a very useful accessory to the meter is a small torch lamp, which is wired in series with the aerial. An ordinary amp of the type used in a 2-cell orch will glow at a useful brilliance when the transmitter is used with most lengths of aerial.

Sometimes the maximum aerial current does not correspond with the minimum plate current and, with the small lamp, you can tune for the maximum aerial current. The lamp also gives an indication of the optimum loading.

LAMP IS USEFUL

If the loading is made too heavy, the aerial current actually decreases. The lamp also acts as a rough modulation indicator as it glows more brightly on the peaks of modulation. This is important o a beginning ham who may not have elaborate modulation monitoring facilities available.

For those who wish to try CW, the transmitter can be keyed by breaking the cathode circuits of the oscillator and the power amplifier simultaneously. With good crystals there should be no trouble with chirp.

The fact that the oscillator can be keyed with good characteristics is a distinct advantage because it makes it possible to work "break-in".

A slight tendency toward keying clicks was eliminated by installing an 8 mfd condenser across the keying circuit. An elaborate click filter as is sometimes necessary with larger transmitters, is not required.

If suitable contacts are available at the key jack, they may be used to short the modulation choke when the key is plugged in and thus provide a slight increase in power for CW.

The regulation of the high tension supply with keying and hence the keying characteristic of the transmitter is assisted by the fact that the modulator valve is drawing current all the time. It operates under the normal class A conditions and draws something in the order of 50 mA.

The modulator follows conventional audio amplifier practice although its gain is a good deal greater because of the omission of feedback, the high value load in the plate circuit of the voltage amplifier and the high gain valve. However, the gain is not so high as to make inconvenient the use of a gain control potentiometer in the input circuit.

MICROPHONE LOAD

A 1.6 meg. potentiometer is specified. This presents a lower-than-normal load to the crystal microphone, which has the effect of reducing the bass response. This is desirable in the case of an amateur modulator because most of the intelligence is conveyed by the higher frequencies.

The power supply arrangement is an exact replica of that used in many broadcast receivers. The total current drain may be slightly higher than the rating of the transformer, but this is not important as operation is intermittent.

The current drain will be well within the ratings of the 5Y3-GT rectifier.

Somewhat greater power output can be obtained by substituting type 5V4-G for the 5Y3-GT. In this case the high tension will be of the order of 300 volts. A slight increase in the value of the bias resistor of the audio power valve together with a screen dropping resistor would be necessary in order to comply with manufacturers' ratings.

In view of the fact that the valve is operating only for short periods at a time, we would be inclined to take the risk of exceeding the published ratings. This is a matter you will have to decide for yourself.

Finally, comes the question of the type of aerial it is desirable to use with the transmitter.

As we have said before, the output network allows practically any piece of wire to be resonated. For operation on 3.5 Mc an aerial measuring about 135 feet from the far insulator to the transmitter terminal would be a good choice. An effort should be made to get the greater part of the aerial as high as possible. The same aerial would work well on 7 Mc.

With this aerial there will be a voltage point at the aerial terminal on both bands. The pea lamp will not glow at full brilliance, but this is actually a good thing because it means that little power is being dissipated in it.

A 67ft aerial would present a voltage point to the transmitter on 7 Mc but a current point on 3.5 Mc. If the lamp glows very brightly in the latter case, it may be a good idea to shunt it with a piece of wire.

Aerials shorter than about 30 feet may be difficult to load efficiently. However, a shorter aerial may serve the purpose, where it is desired to transmit only over a short distance.

The type of aerial you use will govern the optimum selection of taps on the coil. You may find it desirable in some cases to have a greater selection of taps near the bottom of the coil rather than near the top of the coil. The taps we have suggested in the coil data enable you to cope with a wide variety of circumstances.

With this type of aerial the earth return is very important to the radiating efficiency. Aim for a short earth lead with as low a resistance as possible.

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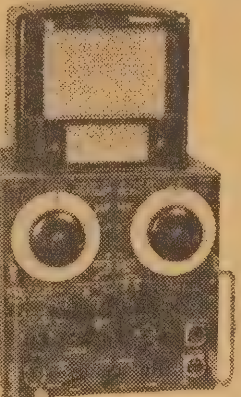

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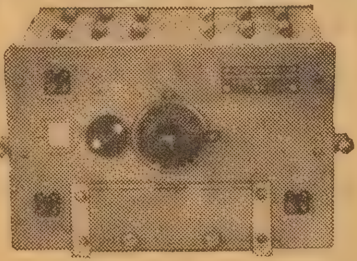

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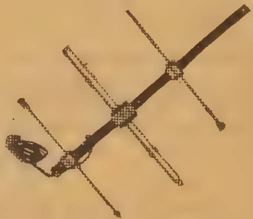

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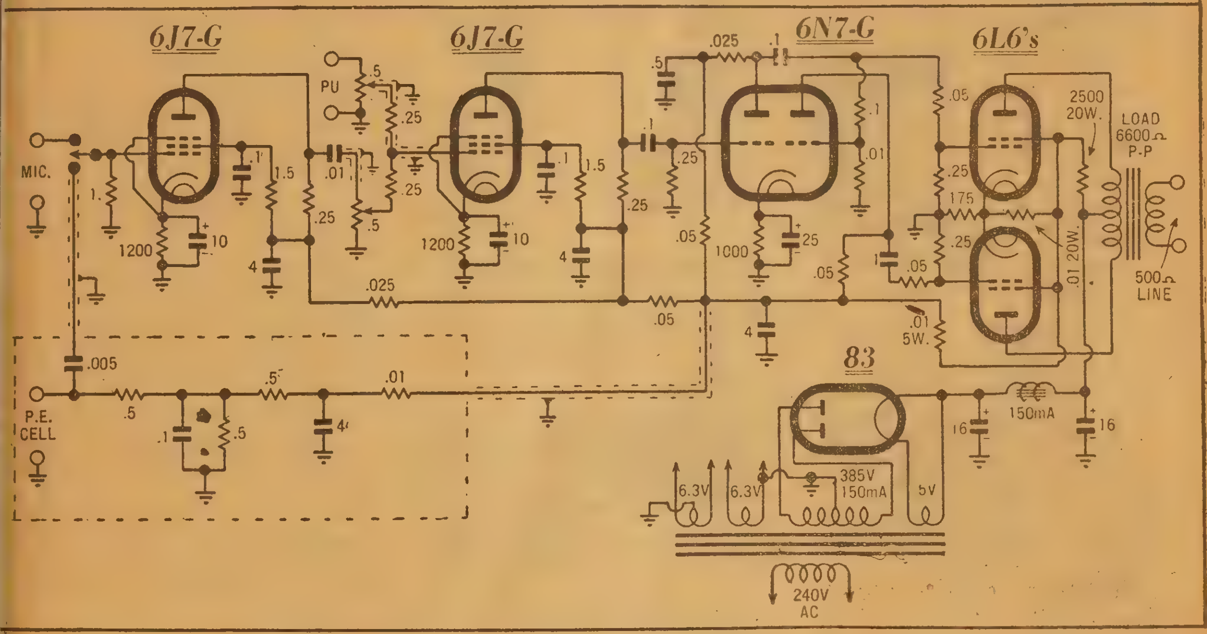

Our contributor for this month is Mr. R. J. Murrell of Herny Creek, Tecoma, via Ferntree Gully, Victoria. According to Mr. Murrell's letter, he has had some previous experience in the construction of such amplifiers, having been associated with cinema work in the "islands" with a branch of the armed forces during World War II.

FOR public address work only, the complete wiring of the photolectric (PE) cell and the switch at he grid of the first valve can be mitted, the microphone connecting irectly into the grid circuit through n appropriate connector.

A crystal microphone may be used s the circuit stands, although there ould be some benefit in increasing he 1 megohm grid resistor to 5 negohm or less. There will be dequate gain for any type of crystal nicrophone. The microphone lead hould be in shielded cable of the low apacitance type. Excessive length hould be avoided, as it would seriusly reduce the output.

A dynamic microphone should nornally be used with its associated input transformer. The first valve grid esistor must remain in position if the E cell facility is required also. If ot, the resistor may be removed. Where this type of microphone is sed with a connecting cable of 0-odd feet or less, the microphone ransformer may be left inside the nicrophone case. In this case, the cable should be of the shielded type, preferably of low capacitance.

For lengths much in excess of this, the transformer is used at the amplifier end of the connecting cable. To avoid hum pick-up, the transformer is connected to the amplifier input with a short length of shielded cable, say a few feet, to keep it out of the magnetic field of the power transformer. The connection between the transformer primary winding and the microphone may, in most cases, be in unshielded cable, since the impedance of this part of the circuit is quite low.

GASEOUS TYPE

For the PE cell, the gas-filled type is the usual preference for film work because of its greater sensitivity. It is to be remembered, however, that this type is more easily damaged from exciting voltage overload. The nominal voltage of operation is 90. At some level beyond this, the gas ionises and the light-sensitive cathode material suffers.

The 90-volt source to the PE cell, in this case across the .1 mfd capacitor near the cell in the circuit, should be read with a high-resistance voltmeter, such as a 20,000 ohms per volt type or a vacuum-tube-voltmeter. The conventional multimeter has a 1000 ohms per volt characteristic, and this comparatively low resistance, even on the 1000-volt range, is sufficient to load the voltage source and give a voltage reading lower than that actually present.

Note that the PE cell circuit components and the leads to the rest of the amplifier should be in shielded wire.

The first two stages of the amplifier are decoupled from the high tension with a resistor and a 4 mfd capacitor. The usual 8 mfd electrolytic may be used here and, as a matter of fact, in any other place where a 4 mfd is shown. Similarly, the 10 mfd may be replaced with the usual 25 mfd 40 PV electrolytics.

The 6L6 valves appear to be operating on the old rating of 400 plate and 300 screen. The present ratings are 360 plate and 270 screen. To conform with these ratings, you could use a vacuum-type rectifier such as the 5U4G, or insert between the rectifier output and the first filter capacitor a resistor of such a value as to drop the voltage between plate and cathode of the 6L6 valves to 360 volts.

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82/6

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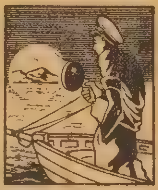

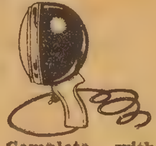

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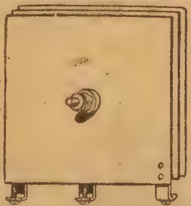

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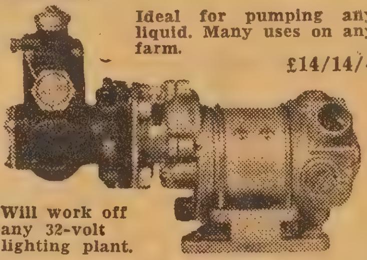

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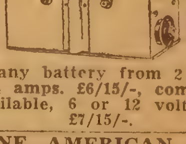

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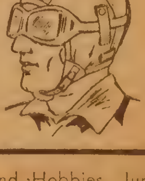

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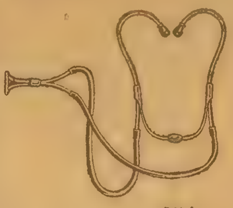

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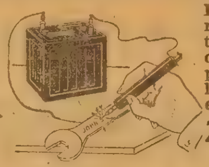

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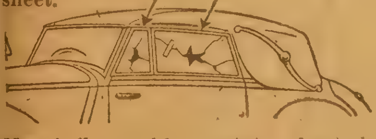

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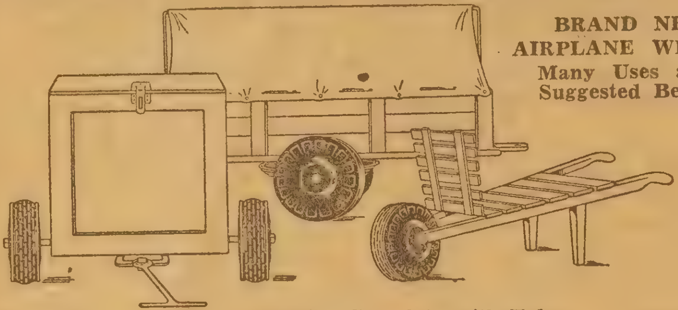

10½ x 4in .. .. .. £5/19/6 each. Complete with Tube.
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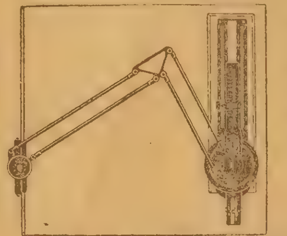

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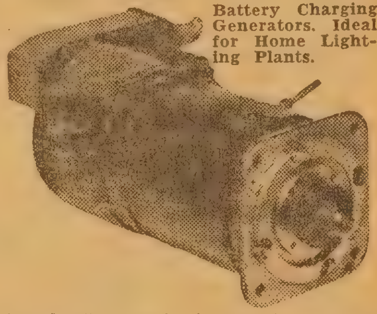

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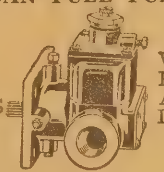
USED BY THE R.A.F.

STAINLESS STEEL VANES



WILL PUMP ANY LIQUID

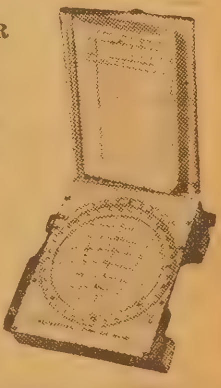
400 gals. per hour, In excellent order, 55/-. Brand new, 75/-.

IN FIRST-CLASS ORDER

DALTON COMPUTERS, IDEAL FOR AERO CLUB, A.T.C., ETC.

Only Limited Stocks Available. Be early.

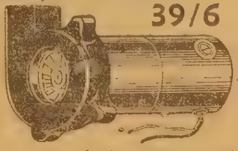
45/-



ENGLISH MOTOR AND BLOWER, 24 VOLTS

39/6

Will Work off 32-volt Lighting Plants.



Larger size also available that will work off 12 or 24 volts, £3/15/-.

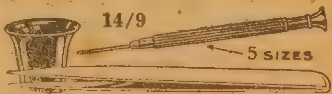
ARMY FOCUSING TELESCOPE

Easily converted for use on dumpy levels.
Can be used as a rifle sight.
Excellent magnification .. £4/19/6.
(Fitted with cross hair.)

ADJUSTABLE FOCUS.

WATCHMAKERS AND INSTRUMENT MAKERS

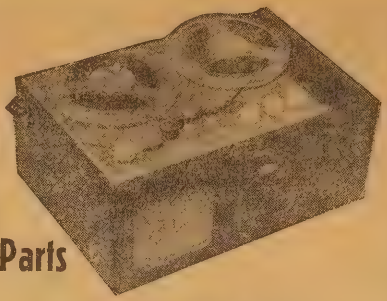
14/9



English Tweezers .. .. .. 6/6 and 5/6
English Pin Vises 7/6
Eyeglasses .. .. 6/6 and 8/6
Extra strong double lens Eyeglass, 15/-

NOVA

BUILD Yourself A Taperecorder or Tapedeck With "NOVATAPE" Parts



WHY PAY MORE AND GET LESS!

"NOVATAPE" parts are the cheapest to buy if you compare quality. A tape recorder built from inferior parts will be useless and whatever is spent on it will be wasted money!

Full money-back guarantee and after-sale assistance.

MAGNETIC RECORDING AND ERASE HEADS

£4/9/6 EACH

One-hole mounting, shielded case with built in tape-guides, nothing extra to buy. Including circuit and details.

"NOVATAPE" Magnetic Heads are used in a number of commercial recorders and thousands have been used successfully by home-builders.

FULLY GUARANTEED. Frequency response, noise level, playback sensitivity etc. are equivalent to the characteristic of the best heads made anywhere in the world. If used with the circuits recommended and good tape the frequency response from 50 c/s to x 2500 c/s at 1⅞ inches per second, 4500 c/s at 3¾ inches per second and to 8000 c/s at 7½ inches per second can be obtained easily.

"NOVATAPE" SUPERSONIC OSCILLATOR COIL

60 kc/s Including circuit and details. 18/6 each

A bias frequency of 60 kc/s is giving better recording with less background noise and lower harmonic distortion.

PROFESSIONAL LIGHTWEIGHT RECORDING DECKS

Of highest fidelity with two motors, fast forward and rewind, 2-speed (all panels and parts machined, blue-print set of photos).

From as low as £28/11/- (Heads extra)

"NOVATAPE" HIGH-FIDELITY Tape Recorder Attachment for Gramophone turntable.

2-speed, hand or 6-minute automatic rewind, fast forward. (Heads extra.)

Kit for only £13/19/6

Assembled and tested with two heads, (Supersonic erase) £29/-/-

Assembled and tested with two heads. (Supersonic erase.) From as low as £46

CONVERTERS. Pre-amplifier/Oscillator Attachment which will give excellent tape recording from wireless or amplifier with any tape-deck.

Kits (incl. valves) circuit and full instructions from £9/18/-

Completely Built-up and tested .. .. from Circuit and details, 5/6. £12/18/-

The LOWEST PRICED TAPERECORDER in AUSTRALIA

"NOVATAPE" Model A including 1200ft tape, 2 reels, microphone £110 (Sydney)

(Plus freight and insurance outside Sydney.)

OTHER TAPEDECKS AND RECORDERS (2 AND 3 HEADS) DETAILS AND PRICES ON APPLICATION

Terms on low deposits and time payments.

ALL PARTS DESCRIBED IN R & H AVAILABLE FROM "NOVATAPE"

"NOVATAPE"

311 SUSSEX STREET, SYDNEY. Phones M2159, M2350.

Open Saturday mornings and weekday nights.

AGENTS: Vic.: J. CLANCY, Phone Wins 3961. S.A.: SCOTT SALES, 99 Currie St., Adelaide. LA1201 or J6749. TAS.: B. HOPWOOD & SON, 107 George St., Launceston. Please inquire from your dealer or forward 6½d stamps and self-addressed envelope for list of prices and further details. **W.A.: V. ARGYLL, 21 Lawler St., Sth. Perth** (Demo of recorder).

CUT OUT HERE

The Manager "Novatape"

Please send me, without obligation, further details and prices of Kitsets for Taperecorders. ☐ *Complete Decks, Amplifiers and Recorders.* ☐ *Oscillator and principal Recording Circuits with description.* ☐ *Points to be considered when building or purchasing Taperecording equipment.* ☐ *Electronic details of taperecording.* ☐

NAME ....

ADDRESS ....

I enclose large self-addressed envelope and 6½d stamp.

SURVEY OF RADAR TECHNIQUES

(Continued from Page 63)

energy to the resonators remain i the interaction space during man RF cycles, while the out-of-phas ones are eliminated after one orbi The net effect of this electron sortir is to build up a whirling space charg pattern having the general shap shown in figure 6.

Since most of the electrons are i the regions or retarding RF fiel at any instant, this pattern has ha as many "spokes" as there are reso ators in the anode.

Although the above discussion ap plies to both pulsed and continuou wave magnetrons, the former type used exclusively in radar applica tions. In such usage a rectangula voltage pulse is applied between th cathode and anode of the magnetro This voltage has a peak amplitud ranging from about 3 kilovolts more than 60 kilovolts for differe magnetrons.

For convenience, since it is difficu to isolate the anode from the outp transmission line and antenna part the anode is usually grounded an the cathode is pulsed negatively.

The duration of the voltage puls is usually very short, ranging in di ferent applications from about one quarter to 10 microseconds. Thes pulses are applied at regular inte vals, called the pulse repetition rat Pulse rates ranging from 200 to 500 p.p.s. are commonly used.

The product of the pulse duratio in micreseconds and the pulse rat in p.p.s. is called the "duty cycle. This factor defines the ratio of tim the magnetron is oscillating to th time it is off.

BRIEF DURATION

Many radar magnetrons operate a 1000 p.p.s. and a pulse duration o 1 microsecond, or a duty cycle o .001. This means that the magnetro is "on" only 1-1000th of the time.

The peak current drawn durin the pulse may be of the order o tens, or even hundreds, of ampere although the average current as indi cated by a DC meter in series wit the magnetron would be much lowe being the peak current times the dut cycle for essentially rectangula pulses.

A performance plot of a typica pulsed magnetron is shown in figur 7. It shows the power output an efficiency of the magnetron as function of applied peak current an voltage for various fixed values o magnetic field. From such data th radar designer can select an appro priate operating point to meet give requirements.

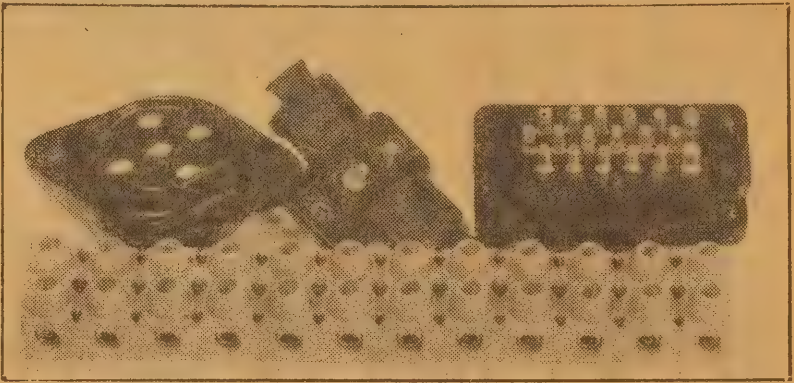
Notice that power output and effici ency increase with increasing mag netic field. The shaded area indicate regions of instability due to interna arcing.

Although the modern magnetro has been instrumental in extendin the limit of efficient radio frequenc generation at least 100 times, it encountering the same kind of limita tions above 30,000 megacycles whic confine conventional triodes to th frequencies below 300 megacycle ("Aerovox Research Worker.")

TRADE REVIEWS AND RELEASES

BELLING-LEE COMPONENTS FROM R.H. CUNNINGHAM

The name of "Belling-Lee" has long been associated with high quality radio components, particularly cable connectors in a wide variety of styles to solve almost any coupling problem. The news that these components are now available in Australia will be welcomed by all sections of the trade.



ESSRS. R. H. CUNNINGHAM, of Melbourne, advised that they are rrying a varied selection of the re popular components in this and, some of which are illustrated this page.

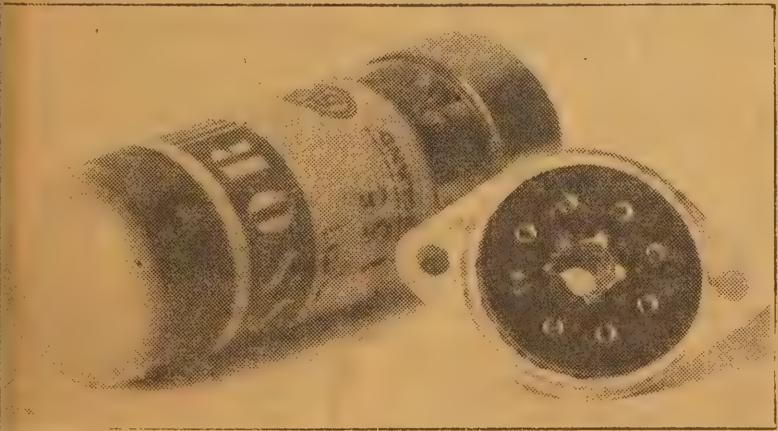
Below is illustrated a twin fuse holder with a neon lid, the purpose of the neon lamps being to indicate which fuse needs replacing. It will operate on AC or DC or not less than 80 volts.

The other illustration shows a selection of connectors. The one on the bottom of the picture is a terminal block moulded in flexible plastic which, besides having desirable electrical characteristics, enables the block to be mounted on almost any irregular surface.

Top right is a "Unitor," a multi-pin plug and socket available in several sizes; top left a high voltage rectifier socket; and centre a plug and socket for a twin aerial feeder.

Further details from R. H. Cunningham, 118 Wattletree Rd., Armadale, Victoria.

NEW 1-INCH SELF-FOCUS CRO TUBE



EADERS who are interested in the one-inch oscilloscope featured ewhere in this issue will be pleased learn that the Australian agents A. C. Cossor Ltd., Jacoby Mitchell d Co. Pty. Ltd., announce that they ve ample stocks of the 1CP1 CRO e used in this instrument.

They also have ample stocks of the ther unusual socket required for s tube and have decided to supply tube complete with socket.

The tube with socket should be available from most wholesalers or from Jacoby Mitchell and Co., price £3/18/6 plus tax.

The various features of the tube, such as automatic focusing, high heater/cathode insulation, moderate high tension voltage, &c., are all aimed at simplifying the design of the complete instrument and thus should appeal to many users not requiring the complexity of a larger instrument. At the same time the tube is capable of excellent performance.

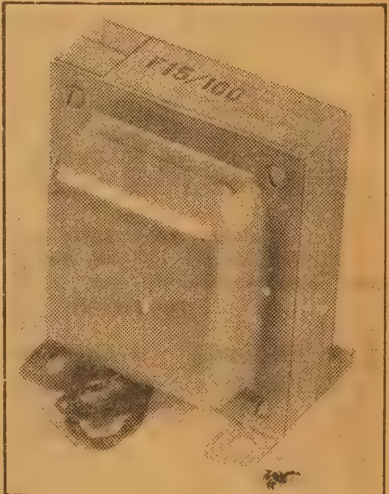
UCC SALES MNGR.

UNITED Capacitor Co. Pty. Ltd. wish to announce that Mr. George Nolte has been recently appointed sales manager of the company.

With a background of technical and commercial experience in the radio industry Mr. Nolte joined UCC as field engineer in 1950 and became assistant sales manager last year.

A member of the Institution of Radio Engineers (Aust.) and of the Wireless Institute of Australia, Mr. Nolte supervised the installation of the two 100 Kw transmitters at Radio Australia while engaged upon development and merchandising with Amalgamated Wireless (A'sia) Ltd.

NATIONAL CHOKES



THE makers of the well-known National transformers announce that they can now supply a range of National filter chokes to match the comprehensive range of power transformers for radios and amplifiers. Pictured above is the F15/100, which is a 15 henry 100 mA choke having a DC resistance of 300 ohms. Further details from Wm. J. McLellan and Co., 122 Sussex St., Sydney.

A & R

. . . . . . AT YOUR SERVICE

DIRECT TO YOU! ALL ITEMS AVAILABLE EX STOCK
IMMEDIATE DELIVERY TO ALL PARTS OF AUSTRALIA

POWER AND FILAMENT TRANSFORMERS

PT's INCLUDE ELECTRO-STATIC SHIELD—ALL TYPES 50 CPS OPERATION

TYPE No.	PRIMARY VOLTS	H.T.V. ASIDE	H.T. mA.	FILAMENTS	PRICE
1682- H	220-230-240	285	60	6.3v-2A; 5v-3A	34/-
1636-3H	200-220-230-240	300	80	2 x 6.3v-2A; 5v-3A	42/9
1332-9H	200-220-230-240	300	120	2 x 6.3v-2A; 5v-3A	53/3
1356-3H	200-220-230-240	400	150	5v-3A; 2.5v-5A; 6.3v-4A	70/-
1380-3H	200-220-230-240	450	200	2 x 6.3v-2A; 5v-3A	95/-
1371-8	200-220-230-240	500-600-750 850-1000	300		150/-
1400-19	200-220-230-240	565-500-425	250	2 x 6.3v-3A; 2 x 2.5v-3A;5v-3A	110/-
1643-23	200 or 230 or 240	—	—	6.3 TAP 5v-2A (500v insul)	17/6
1525-21	200-230-240	—	—	2.5v-10A (1000v insul)	47/6
1305-22	200-220-230-240	—	—	2.5v-10A (3000v insul)	75/-

FILTER CHOKES

Swinging Chokes Marked *

TYPE No.	INDUCTANCES-HYS.		CURRENT mA.	APPROX. D.C. RES.	MAX D.C. Working Vol.	PRI
	MAX.	FULL RATE DC				
957-23	20	15	60	320	500	16/6
973-9	30	20	80	370	500	33/6
973-21	30	20	80	370	500	25/9
1012-1A	35	20	120	430	1000	35/3
967-1A	35	20	150	200	1000	46/-
956-1A	30	20	200	160	1000	57/9
1011-1A	30	15	250	160	1000	59/6
983-1A	25	20/5	30/300	90	1000	65/6
986-1A	15	10	300	60	1000	62/6

AUDIO OUTPUT TRANSFORMERS

* Response Includes Correction due to Negative Feedback ** For Use With Rola 12-OX Speaker

TYPE AND MOUNTING	IMPEDANCE—OHMS		FREQ. RESPONSE		RATING WATTS	TYPICAL APPLICATION	PRICE
	PRIMARY	SECONDARY	DB+—	CPS			
893-23	5000, 7000	2, 3.7, 8, 12.5	1	*40-15,000	5	SINGLE 6V6G, 6AQ5 ETC, TO VC	28/3
894-23	500	2, 3.7, 8, 12.5	2	50-10,000	5	LINE TO VOICE COIL	26/3
900-22	2500, 5000	2, 3.7, 8, 12.5, 15	1	*40-15,000	15	SINGLE 807, EL34 ETC, TO VC	57/6
896-9	8000, 10,000	2, 3.7, 8, 12.5, 15	1	30-15,000	15	PP 6V6G's A OR AB1 TO VC	62/6
897-9	8000, 10,000	100, 125, 166, 250, 500	1	30-15,000	15	PP 6V6G's A OR AB1 TO LINE	62/6
763-9	3000, 5000	2, 3.7, 8, 12.5, 15	1	40-20,000	15	PP 2A3's A OR AB1 TO VC	62/6
809-26	500	2, 3.7, 8, 12.5, 15	1	50-20,000	15	LINE TO VOICE COIL	42/6
870-26	10,000	2 or 8	1	*20-20,000	6**	PP 6V6G's OR 807's AS TRIODES	57/6
871-9	10,000	2 or 8	1	*20-20,000	12	PP 6V6G's OR 807's AS TRIODES	81/-
872-9	10,000	3.7 or 15	1	*20-20,000	12	PP 6V6G's OR 807's AS TRIODES	81/-
891-22	6600	83, 100, 125, 166, 250, 500	1	50-12,000	35	PP 807's AB1 TO LINE	82/6
892-22	3200	50, 62, 83, 125, 250, 500	1	50-12,000	55	PP 807's AB2 TO LINE	97/-

INPUT TO GRID TRANSFORMERS

511-10	50-100,000 OHMS	MUMETAL CORE	30-10,000 CPS	65/-
509-10	200-100,000 OHMS	MUMETAL CORE	30-10,000 CPS	65/-
502-10	600-100,000 OHMS	MUMETAL CORE	30-10,000 CPS	65/-
563-6	600-60,000 OHMS	STALLOY CORE	200-5000 CPS	42/6

INTERSTAGE TRANSFORMERS

518-6	20,000 TO 20,000 OHMS	SE OR PP	RADIOMETAL CORE	1:1 RATIO 30-10,000 CPS	69/-
519-6	20,000 TO 80,000 OHMS	SE OR PP	RADIOMETAL CORE	1:2 RATIO 30-10,000 CPS	69/-
620-6	20,000 TO 180,000 OHMS	SINGLE ENDED	RADIOMETAL CORE	1:3 RATIO 30-10,000 CPS	69/-

DRIVER TRANSFORMERS

545-9	SE 4000 TO PP AB2 GRIDS 1.6:1. PRIM. TO ½ SEC RATIO 50-10,000 CPS 5 WATTS	57/6
588-6	SE OR PP 5000 TO PP 807's CLASS B. 200-5000 CPS 5 WATTS	52/6

LOW LEVEL OUTPUT TO LINE TRANSFORMERS

705-6	PP 30,000-600 OHMS	RADIOMETAL CORE. MAX. LEVEL 250 MW. 30-10,000CPS	69/-
712-6	PP 30,000-200 OHMS	RADIOMETAL CORE. MAX. LEVEL 250 MW. 30-10,000CPS	69/-
710-6	SE OR PP 20,000-600 OHMS	RADIOMETAL CORE. MAX. LEVEL 250 MW. 30-10,000CPS	69/-
720-6	SE OR PP 20,000-200 OHMS	RADIOMETAL CORE. MAX. LEVEL 250 MW. 30-10,000CPS	69/-

MODULATION TRANSFORMERS

Primary: 3,800, 5,000, 6,600, 8,500; 10.000 ohms Secondary: 4,000, 5,000, 6,000, 8,000; 10;000 ohms.
150mA. D.C. per side on Primary. 150mA. D.C. Maximum Secondary Current.
Freq. Response: 200-7,000 c.p.s. 75 Watts Rating £9/10/-:

★ **NOTE: 20% SALES TAX TO BE ADDED TO ABOVE PRICE**

★ **MOUNTING DETAILS:**

H—3H: Horizontal mount with steel louvred cover. Sub-terminal panel.
—8: Open steel clamps. Terminal strip prim. & sec.
—19: Horizontal 6in x 5in cast cover. Sub-terminal panel.
26—23: Open steel brackets. Terminal stri
6—10—9: Diecast case with solder termina
—21: Open steel clamps. Terminal stri
—22: Open steel clamps. Terminal stri
—1A: Vertical steel louvred covers leads.

In Melbourne? Buy From Our Own Showroom. Country or Interstate? Use Our Fast Mail Order Servic
Catalogue now Available—Write for YOUR Copy!

For the Transformers You Need, Call, Write or Telephone to:—

A & R ELECTRONIC EQUIPMENT COMPANY PTY. LTD.

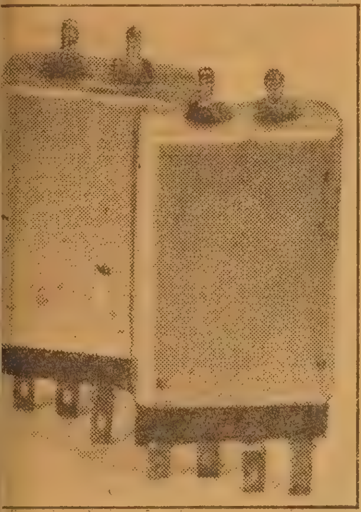
HEAD OFFICE, FACTORY AND SALES: 378 ST. KILDA ROAD, MELBOURNE, VIC.
TELEGRAMS: "ARLEC," MELBOURNE (OPPOSITE THE SHRINE) TELEPHONE: MX1150.

★ **A & R FOR QUALITY** ★

MINIATURE IFT's

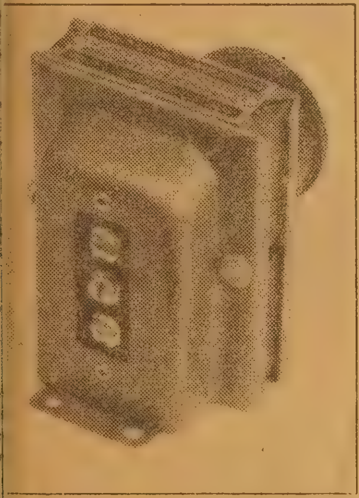
F particular interest to builders of miniature equipment, such as rtable communication systems, is miniature IF transformer recently leased by Philips Electrical Indus- ies Pty. Ltd.

The unit is designed for 455 Kc d employs the new HF magnetic



aterial "Ferroxcube," which is an vention of the Philips organisation. nis, in conjunction with another ilips development, miniature ire" capacitors, makes possible a ghly efficient unit in a small space. Can dimensions are 1in x 13-32in 1 7-16in (high). Tuning is by eans of adjustable iron cores.

HIME AND BELL TRANSFORMER



ATEST addition to the extensive range of transformers by Ferguson ansformers is one designed speci- ly for the operation of doorbells, izzers and chimes.

Known as the type PF648, it is signed for 240 volt input and an itput of four, eight or 12 volts. ith a continuous rating of 10 watts has an intermittent rating of two nps from the secondary tappings.

Further information from Ferguson ansformers Pty. Ltd., Ferguson anc, Chatswood, or their agents.

A TAPE RECORDER for £12/10/-

complete in kit set form using the radio as the amplifier and the turntable as the drive. All mechanical parts made and all the necessary resistors and condensers, oscillator coil, chokes, tapes, reels. Record/play head kit supplied to build this one-valve (twin triode) circuit. 6SN7 valve not supplied with the kit.

Supersonic Erase Kit 12/6 extra.

ENDLESS HOME ENTERTAINMENT FOR AN OUTLAY OF ONLY £12/10/-.

RECORDING ACCESSORIES

MAGNETIC RECORDING HEADS

1. High Impedance, super high fidelity, single hole mounting, attractively finished in polished aluminium case and featuring the latest unique double gape, i.e. two heads in one for longer life. Twin or single track. Frequency range 25-8500 cps. Undoubtedly the best heads we have stocked. Twin or single track. Price, inc tax **£5/9/9**

Erase as above £5/9/9.

2. L.B. PRODUCTS HEADS

L.I. low impedance. Price, inc. tax **£6/6/-**

H.L.I. high and low impedance wide frequency range. Three hole mounting, cast case, grey finish. Price, inc tax. **£10/7/-**

ERASE, as above. Price, inc tax. **£6/6/-**

RECORD/PLAY HEAD KITS

3. High impedance specially wound bobbin on plastic former, strip of heat treated Mu Metal, solder. Plated case. Singe hole mount. Full instructions. Possible frequency range 50-7000cps.

Price, inc tax. **£1/12/6**

OSCILLATOR COILS

O.M.E. Supersonic, adjustable slug, 40Kc. High and low impedance. A truly first-class coil in shield can. Complete with circuit. Price **18/6**

LOW IMPEDANCE ERASE KIT

Plated head case, heat treated MU METAL strip, winding wire, solder paper, solder, full instructions. Price, inc tax. **17/6**

RECORDING TAPE

E.M.I. H60A 600ft	£1 14 0
E.M.I. H60A 1200ft	£2 18 0
SCOTCH BOY A.1. 1200ft	£3 12 6
SOUNDMIRROR 1200ft	£2 15 0
MAGICTAPE 1200ft	£3 15 0

EMPTY REELS, METAL, PLASTIC, OR FIBRE from 8/6.

SPOOL HOLDERS

1. Pressed aluminium precision made 3/16in and ¼in hole. Price each	**12/6**
2. Chrome holders, screw top ¼in hole Price pair	**22/6**
Recorder Motors B.S.R.	£3/10/-
Bearings, self-oiling, from	9d each
Pinch Wheels inc. Bearing	10/6 each
Pinch wheel shafts, precision ground	7/6
Amplifier circuits	7/6 each
MU METAL STRIPS, heat treated	3/- and 6/6 strip

FLYWHEEL and 2-speed Capstan 3¾-7½in per second. Dynamically balanced, precision turned, complete with bearings, mountings and thrust ball £3/17/6

MICROPHONES. Ronettes from £1/10/-

TAPE RECORDER DECKS

An ENTIRELY NEW TYPE OF DECK, TWIN SPEED 3¾-7½ per second, fast rewind, single function switch, 2 MOTORS, AUTO TAPE LIFT, UNCONDITIONALLY GUARANTEED, FINISHED N BLUE OR GREY, £32/10/-, LESS HEADS. COMPLETE WTH HEADS 25-800 CPS £43/9/6

TAPE CONVERTOR AND PRE AMP-OSCILLATOR

TURN YOUR RADIO INTO A TAPE RECORDER AMPLIFIER, 2 Valves, Microphone input, Record/Play, and erase terminals. Separate volume control exclusive to M.S.I. £12/10/-

AUSTRALIA'S ONLY RECORDING SPECIALIST

Recommends and stocks only the leading makes of new complete tape recorders. The following carry their full guarantee and approval.

		NEW	USED FROM
MAGICTAPE (A.W.A., PYROX.)	TWIN TRACK	£135 8 4	£85 0 0
ELCON	SINGLE TRACK	£125 0 0	£85 0 0
TECNICORDER		£129 0 0	———
SAPPHIRE	TWIN TRACK 2 SPEED	£138 10 0	———
SOUNDMIRROR (Imported model)	SINGLE TRACK	£152 10 0	£90 0 0

Other slightly used Recorders from £65. All available on small deposit and from 17/6 weekly.

TRADE DISCOUNTS NOW AVAILABLE.

HIRE A TAPE RECORDER
WEEKEND OR NIGHTLY

MAIL ORDER WITH CONFIDENCE FROM OUR EXTENSIVE RANGE.

Please add postage.

MAGNETIC SOUND INDUSTRIES (AUST.)

1st Floor, Crystal Palace Arcade,
590 George Street
Opposite the Regent M3393 Open Saturday mornnig

SHORT-WAVE NOTES BY ART CUSHE

VERIFICATION FROM SINGAPORE

Confirmation of our reception of the new Forces Broadcasting Service, Singapore, mentioned in the last issue, is to hand.

MUCH to our surprise, we learn that the Forces Service at Singapore had been in operation for more than a year before it was heard in this area. The main reason for its signal being unheard of in this area, is the fact that the transmission is beamed up the Malay Peninsula, and up to April 1, 1953, the frequency of 4963 kcs was used, which was badly interfered with by Delhi, India, on 4960 kcs.

Forces Broadcasting Service, Singapore, opens at 9.45 pm, when a tone note is broadcast, cut at 9.59 pm. At 10 pm, the program opens with fanfare of trumpets, announcement in English, "This is the Forces Broadcasting Service!" It is faded by a march, which is faded out and from then on, for the next half-hour, the East African program is broadcast in Swahili and Chinyanja.

At 10.30 pm, for half an hour duration, a program in Fijian is broadcast. At 11 pm, the program is taken over for Gurkhas and continues for an hour, when they close at midnight. The station operates on 5010 kilocycles, and uses a 7500 watt RCA transmitter, with stacked signal aerial reflectors, which beam the signal up the Malay Peninsula.

An English session will shortly be introduced in the program to provide entertainment for the many British Forces in the area.

Reports of reception are appreciated and should be addressed to Cpt. J. O. Ettridge, OC Forces Broadcasting Unit, GHQ, Far East Land Forces, Singapore, Malaya.

WESTERN SAMOA TESTING

Apia, Western Samoa, is to commence a series of test broadcasts on 6040 kcs from the end of May for at least a month. Though it had been known for some time that ZM2AP in Apia, which operates on 1420 kc broadcast band, was contemplating the use of short-wave for additional coverage, we have now been informed that the tests are to be commenced in late May.

The station is operated by the New Zealand Broadcasting Service. After testing on 6040 kcs for at least a month, so that they can get reception reports from listeners giving an overall picture of reception, the station will carry out further tests on 3241 kcs. Reports will be much appreciated from listeners and should be addressed to the Chief Engineer, Radio Station ZM2AP, Apia, Samoa. The station operates on Sun., Tue., Sat., 3.30-7 pm, Monday, 4.30-5.30 pm.

SUVA OUTLETS

Suva, Fiji, which has been covered in recent issues, during its series of test broadcasts, is now using an additional transmitter in the 49-metre band. Suva operates on 5995 kcs, but a further frequency, 6100 kcs, has been heard in chain. The latter station, which is not announced when frequencies are given, is understood to be operated by the Fijian Post Office. Both stations have been heard in the 3.30-8 pm transmission. The 6100 kcs outlet suffers from rather severe interference from Peiping.

THAI ARMY STATION

Thailand, like Greece, has several radio stations operated by the Forces, and this month we have heard the first of the Thailand stations, several of which are known to be in operation. The one we are hearing is HS1JS, Bangkok, on 4875 kcs, heard at 9.30 pm, with a recorded musical program. Signals are fairly good, but little is given in the way of identification announcements. The station operated by the Military Corps Radio Service of the Thai Army, has HS1JS (4875 kcs), 250 watts, assigned to it, with alternate frequencies of 5800, 6200 kcs.

NOTES for the next issue, close on June 6, at 212 Earn St., Invercargill, N.Z. Times given are all Australian Eastern Standard Time.

International short-wave broadcasting was commenced in Germany on May 3, when the new short-wave service at Hamburg was opened. Transmissions are: FAR EAST, 8.30-11.30 pm (15275 kcs); NEAR EAST, 12.30-3.30 am (11795); AFRICA, 4.0-7.0 am (11795); SOUTH AMERICA, 8.0-11.0 am (11795); NORTH AMERICA, 11.30 am-2.30 pm (7290, 6270). Listeners' letters are requested to "Deutsche Welle," Kurzwellendienst, Koln, Funkhaus, NWDR. A mailbag session to the Far East is scheduled on Tuesday at 9.30-9.40 pm, during which time reports will be acknowledged.

NEW VOA CALL SIGN

WDSI, New York, replaces WABC as a new Voice of America relay station, WABC being assigned to the key station of the American Broadcasting Company.

Kcs	Call	Schedule
6120	WDSI-2	1.15-1.45 pm.
6170	WDSI-1	12.15-12.45, 1.0-1.45 pm.
9530	WDSI-3	1.0-1.45 pm.
9615	WDSI-4	7.0-8.45 am.
9650	WDSI-3	10.0-10.30 am (Mon.-Sat. UN), 10.30-11.0 am, 6.0-8.0, 9.0-9.15 am, 12.30-12.45 pm.
11790	WDSI-1	10.15-10.30 am (Mon.-Sat.-UN), 10.30-11.0 am.
11830	WDSI-1	10.0-10.15 am, 6.0-8.0, 9.0-9.15 am.
11870	WDSI-5	4.0-8.45 am.
15270	WDSI-2	10.0 am-12.30 pm, 10.30 pm-8.45 am.
17830	WDSI-3	10.30 pm-5.30 am.
21570-	WDSI-1	10.30 pm-3.30 am.

DIGEST OF DX TIPS

Kcs.	Call and Location	Time Heard (AEST)
4860	YVPA San Felipe, Venezuela.	Opens 8.30 pm.
6130	CHNX Halifax. N.S. Canada.	Opens 7.59 pm with "God Save the Queen".
7210	LLS Oslo, Norway.	To Pacific Area 2.00-3.00 pm.
7415	Athens Forces, Greece.	1.00-8.04 am.
9144	ORU Brussels, Belgium.	English to 1.00 pm
9510	YVXJ Barquisimeto, Ven.	Sign on 8.30 pm.
9590	Hilversum, Holland.	To Pacific 12.30-1.10 pm.
11880	Stockholm, Sweden.	English News 2.00 pm.
13620	Peiping, China.	1.00-1.30 pm.

FLASHES FROM EVERYWHERE

NEW GREEK FORCES STATION
Athens, is at present testing on 7415k
and requesting reports to the Cent
Broadcasting Station of Greek Arm
Forces, 3 Kakolostas St., Athens. Eu
pean listeners report reception best
8.4 am, but Jack Corbett, Brisbane,
hearing the station in an afterno
transmission at 4.30 pm.

NORWAY'S PACIFIC SERVICE, wh
is now carried in the afternoon, as
the case with Holland and Belgium,
to poor night reception, uses LLG (961
LLS (7210), LKJ (6130) and LKQ (1172
for a new West Coast, North America,
Pacific area from 2.0 to 3.0 pm daily.
Monday the service is extended to
pm.

RADIO TRINIDAD'S use of the
metre band, 3275kcs, has resulted in
station being widely reported in this ar
Radio Trinidad, opens at 8.0 pm with
short musical item, which is followed
a religious broadcast. The station fa
out around 8.30 pm. The compl
schedule of Trinidad, which is located
Port-of-Spain, is, 3275kcs, 8.0-1.0
6085kcs, 8.0-6.0 am.

RADIO JAMAICA, located at Ki
ston, is a further West Indian stat
now using the 85-metre band, and
heard on 3360kcs, from opening at
pm, with "The Church in the Wildwoo
Jamaica formerly was using 4950kcs,
the complete schedule is 9.0-2.0 pm.

RADIO FREE ASIA'S exit from
short-wave field was April 30, when
transmitters were closed down. The F
Asia Committee is to use the broadc
facilities of nearby stations to the Chin
mainland, in order to get broadcasts i
Communist China. Radio Australia in
leasing this news, also mentioned that
San Francisco stations, which broadc
the Radio Free Asia programs for
broadcast by the Guam and Manila static
would also cease to operate.

**CANADIAN BROADCASTING CORP
ATION'S** relay station CBFW, Montr
which relays medium wave CBF, has
ceased to operate, due to the expan
broadcast band coverage of the C
in the Quebec and Atlantic Coast area

**BFEBS SINGAPORE'S CORONATI
BROADCAST** will be carried on seve
new frequencies. Transmission to A
tralia will be as follows:—

5.0-2.45 am—7120,9690,11820kcs.
4.30-7.30 am—7120,9690kcs.
6.0-6.15 am—6110,6175kcs.

These frequencies are for the Cor
ation broadcasts only, but one can
pect BFEBS to use these frequencies
later broadcasts if they prove succ
ful. The Coronation will also be carr
on 17755, 15435, 11880, 15300, 11955, 9
7260kcs.

**RADIO PEIPING'S ENGLISH BRO
CASTS** are now carried at a new tra
mission time, 1.0 pm on 15060 and 1
kcs. The latter frequency is new,
is not a success, due to cw interfere
This broadcast replaces the former
am session. Other English broadc
remain at 7.0 and 11.30 pm.

EGYPT'S NEW 100KW TRANSMITT
were officially opened in late April,
at present are experimenting with bro
casts on 6085kcs, 2.30-5.0 pm, 2.0-6.30
and on 9750kcs, 6.0-7.30, 10.0-11.0 pm,
cording to Radio Sweden.

HCJB'S 100KW TRANSMITTER is
to be operating by late 1953 from
new transmitter site at Pifo, out
Quito. This news was passed on to
by Mr. G. H. Ohlsen, Newcastle. HC
Southern Cross Salute beamed to A
tralia and New Zealand on 15115, 1
and 9745kcs, is transmitted 4.30-6.0

RADIO FRANCE ASIE'S transmis
to Australia and New Zealand on 1
kcs, will be found to be weaker du
the winter months, but Clive Malo
of Dept. of Education, Perth, WA, rep
signals still good in his location
English news at 8.0 pm.

THE HAM BANDS WITH BILL MOORE

The new Technical Class of licence which the PMG's Department intends to issue shortly should attract many radio enthusiasts to the transmitting ranks. Learning Morse code has often been a problem to many who had ideas of becoming radio amateurs. This licence with no Morse requirement, will allow these experimenters to join the ranks of amateurs.

HE announcement by the Federal executive of the WIA that after prolonged egotiations, the Postmaster-General has greed to issue Technical Class licences ill be of considerable interest to many dio enthusiasts. This new licence will e issued on similar lines to the class perating in the US, and the department as requested by the WIA some time ago issue this and the Novice Class of cence.

Licensees will be permitted to operate n the VHF and UHF bands, 144 mc and bove. The influx of additional stations n this portion of the spectrum should ssist those amateurs already operating here. Development of these bands is ur most important function.

Licences will be available to fully tech- ically qualified persons. It will allow hose radio enthusiasts who cannot mas- er the Morse code, or do not have the ecessary spare time to learn it, to enjoy mited transmitting facilities.

NOT AVAILABLE YET

It will be some time before the Tech- ical class of licence will be available or issue, as the department has yet to make the required administrative hanges.

At the same time, a request was made o the department to consider issuing Novice class licences (5 WPM Morse Code requirement and limited technical re- uirement current for one year only). The equest has been refused, but further onsideration will be given to the sub- ect.

Some indication of the popularity of hese classes in the US can be gained rom the 1952 licence figures over there. During the year, 22,172 licences were ssued, 12,087 were of the Novice class, 371 Technical class. Total number of icences current at the end of 1952—10,968.

Another change to be effected in the egulations will be a variation in the age imit for amateur radio operators. The VIA requested that the PMG's Depart- ment consider lowering the age limit rom 18 to 16 years for amateurs. The department has agreed to the request.

The Federal executive has arranged hat representatives of the Wireless In- titute of Australia will appear before he Royal Commission on television. They will present the case for the radio ama- eurs and deliberations could have an im- portant bearing on future amateur activity on television and TVI problems. The re- port on the proceedings will be awaited with interest.

GROWING MEMBERSHIP

The Quarter Century Wireless Associa- ion was founded in 1947, the result of a discussion on the 28 mc band by a num- ber of old-timers residing in New York City. They decided that old-timers in amateur radio should have the opportun- ty of gathering together and reviewing he "good old days." From an initial membership of 35, the list now stands at 40, drawn from amateurs all over the world.

Over 175 members attended the fifth anniversary celebrations, held in New York City. Paul Godley, ex-2ZE, described the reception of the first amateur signals across the Atlantic on 200 metres, and reviewed the work in 1921 in England.

President is John Diblasi, W2FX, vice-president George Droste, W2IN, and secretary Leon Hansen, W2FIT, treasurer David Talley, W2PF. All have held office since the inauguration of the association.

The main objects of the association are to:—

Foster and develop friendship and co-operation amongst amateur wireless and radio operators of more than 25 years' standing.

To take a general interest in all matters affecting or involving amateur radio and sponsor such action as may be deemed proper in their interests.

In connection with the above aims, the QCWA has been supporting the Braille technical press, which prints articles in Braille from CQ and ARRL Publications, for the benefit of blind radio amateurs.

NOMINAL FEES

Membership dues, which are nominal—only 1 dol. per year—help to pay for the cost of posting the Quarterly QCWA Bulletin and for producing a certificate issued to all members. The certificate depicts "The Old Man" as the insignia of the association.

Those amateurs who were licensed as radio amateurs 25 or more years ago and are currently licensed, are eligible for membership.

Application forms can be obtained from David Talley, W2PF, 130 Martense St., Brooklyn 26, NY, USA.

The American Radio Relay League also issues an attractive certificate to radio amateurs who qualify for their "Old-Timers' Club." The qualifying period is 20 years, and applicants should hold a current licence. Open to all amateurs, a brief resume of your amateur radio activity in the 20 years should be forwarded direct with application to ARRL headquarters.

Latest developments in the amateur radio mobile field in the US is the use of linear amplifiers. Using inputs up to 250 watts, with only 1 watt of driving power, excellent results are being obtained. Three phase engine-driven generators are used, and about 2 to 2½ hp is consumed in running the equipment. Transmitters are using the new midget vacuum variable condensers, greatly reducing the physical size of the equipment.

Using a 13 1-3 foot whip, the best DX to date is Alaska and the Caroline Islands. Incidentally, to allow more effective operation of the extensive electrical equipment now supplied with most cars, a number of manufacturers in the US have changed from 6-volt to 12-volt electrical systems. It is thought that within the next few years all car systems will be changed to 12-volt. Amateurs will appreciate such a variation which will allow them to run up to 30 watts input from vibrators.

SILENT KEYS

It is with deep regret the passing is recorded of Dr. David Monk Adams, VK2AE, at the early age of 33 years.

Dave was extremely active prewar and became very well known in DX circles. First licensed in 1934, he was then only 14 years of age, and the youngest amateur in Australia. He had qualified for his AOCP some years previously.

In 1936 he won th[illegible] junior section of the BERU contest and, with Ivan Miller, VK3EG, and Eric Trebilcock, gave Australia victory in all sections of the contest. VK2AE participated in the Australian National Field Day in 1937, and was one of the few Australian stations to contact 100 different countries prior to 1939.

Dave had a very distinguished scholas-

(Continued on Page 93)

VHF LINKS BECOMING LONGER

The 144 mc gang in NSW are still working toward a complete State-wide coverage. Further links in the net recently made are as follow:—Bill Brook, VK2ACT, Dubbo, contacted John Miller, VK2ANF, Sydney, on a number of occasions. Distance, 180 miles. Tom Stroud, VK2AMR, of Dubbo, has also been heard in Sydney.

Bill Brook, VK2ACT, has also contacted Allan Thackeray, VK2TA, of Young, 140 miles, and Laurie West, VK2EI, of Parkes. Another link completed is from Hugh Stitt, VK2WH, Forbes, to Jim Edge, VK2AJO, of Coolamon, distance 110 miles.

In contact recently on 3.5 m/cs, were Arch Cox, VK2GU, Canberra, Hugh Stitt, VK2WH, Forbes, and Jack Hill, VK2ADT. They decided to change frequency to 144 mc, when VK2GU and VK2WH could hear both other stations, distances up to 200 miles. VK2ADT, who was using a converted ASV receiver and heard nothing, has a cascade converter operating already.

The May meeting of the NSW UHF section was held, with the new chairman, Bob Winch, VK2OA, presiding. Creating considerable interest was a re-play of two tapes recorded by John Moyle, VK2JU, and Bert Beresford, VK2ABB, of the recent Civil Defence Emergency Net practice.

Berry offered comment on the procedure used during the practice, and it is evident that extensive practice in message handling is required. Recordings of this type will prove invaluable to trace the progress of the net and to allow members to review their efforts during practice.

The net have decided to adopt the following frequencies for the zones as under:—Northern, 144.72 mc/s, Eastern, 146.07 mc/s; Western, 147.1 mc/s. The remaining zone frequencies have yet to be selected. VK2WI will operate on 145.0 mc/s.

The world 420 mc DX record was recently shattered in Europe, when ON4UV, Belgium, and GW2ADZ, Wales, contacted over a distance of 350 miles. The contact was repeated a few weeks later. The greatest distance covered one way still stands at over the 500-mile mark, when F9BG heard FA8IF across the Mediterranean.

Activity on 420 mc/s in Europe is well ahead in most phases compared with the US. In Europe only two bands are available for UHF operation, 145 and 420 mc/s, while W stations spread their activity over the 50, 144, 220 and 420 mc bands. The latter feature probably accounts for the lead held by the European amateurs.

Further 144 mc links in country NSW include Geoff Page, VK2BQ, Tumut, to VK2WH, Forbes—140 miles. Norm Skulander, VK2JW, Orange, has contacted VK2TA, Young, and VK2ACT, Dubbo.

The Forbes-Sydney link, VK2WH to VK2ANF, 190 miles, is now active, using FM. Some improvement is noted over the AM previously used. Experiments are still being carried out to obtain the ultimate gain from the equipment in use. Using CW, communication between the two stations is practically 100 pc, using FM only about 80 pc would be a fair estimate of the effectivenes of the telephony link. Main problem is a deep fade that occurs at irregularly spaced intervals.

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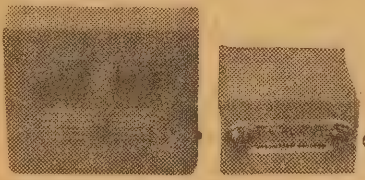

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with standard & microgroove crystal heads. in leatherette cabinet

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A.C. 5 valve using single ended high gain tubes.

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OUR TECHNICAL SERVICE AVAILABLE AT ALL HOURS BY PHONE AT EITHER ADDRESS.

:areer, graduating BSc with first-class ›rs, and Sydney University medal, in ; MB, BS, with second-class honors, .945, and MSc in 1947. He had also pleted his thesis for his doctorate in osophy.

1948 he proceeded to Canada on a e-year Rockefeller scholarship for ical research. On his return to Syd- he was appointed a lecturer and r at Sydney University.

ave suffered ill-health from an early and while in Canada was convalescent over 12 months after a serious ill- ;. Whilst overseas, he visited a num- of amateur stations and would soon e been active again. In January of year, at the NSW Division's annual ıfest, he spoke enthusiastically of his ıre plans for equipment and opera- .

is passing will be felt by many ama- rs and condolence is extended to his ily.

he news of the passing of Jack ›blewhite, VK2IN, on May 10, at the of 64, was received with deep regret.

ack, although only licensed postwar, ; an enthusiastic radio experimenter many years. He was nearing 60 years age when he qualified for his AOCP became a very proficient operator, pite his late start on the Morse code. he 10-metre band attracted him most l, using folded dipoles, contacted much on CW and telephony. He was active times on all bands, 10 through to 80 tres. His equipment, always beauti- ly constructed, was admired by all o had the privilege of inspecting it.

:eb was an ardent supporter of the A, although not actively engaged in affairs—his business commitments re too exacting—he believed the future amateur radio lay in a strong and ective institute.

ack was a leading Sydney business- n—managing director of Beard, Wat- ı's Pty. Ltd., for 25 years.

.I.A. NEWS

The Adams Trophy for 1953, awarded nually for the best article from a NSW ember, published in Amateur Radio, was animously voted at the April meet- ; of the NSW Division to Noel South- ll, VK2ZS, for his two articles on ingle side band transmission."

The April meeting of the Hunter anch was held at the alternate venue, aitland. An interesting lecture and de- ›nstration of Pye portable and mobile uipment was presented.

The Canberra Amateur Radio Club embership now stands at 50 and per- anent clubrooms have been procured at verside Centre. Started in 1951 by six nateurs, it has grown rapidly and will ortly commence lectures for interested rsons. Anyone in the ACT, desirous of ining a progressive club, should con- ct the secretary at PO Box 59, King- on, ACT.

June meetings. NSW UHF Section, June at Science House, Gloucester St., Syd- ey; Hunter Branch, June 12, at Tech- cal College, Tighes Hill, Newcastle.

X AND PERSONAL

Provided there are no further delays, the X expedition to Easter Island will be perating CEOAA from that QTH, as om May 20. The venture has been post- ›ned on a number of occasions, but 2BAK reports the above information as ie latest news.

VQ4NZK is active from Kenya, using watts to a folded dipole. A movie pro- ucer, he will operate later in VQ3 and Q5, and from Zanzibar, VQ1, in his ext production.

Daily Press announced during April :.: Mr. Casey, Minister for External ffairs, stated that £950,000 worth of radio quipment would be given to Pakistan nder the Colombo Plan. The equip- ent includes broadcasting transmitters nd apparatus designed to improve the ınge of Radio Pakistan.

Most amateurs appreciate the effective ›ver provided by that service, especially with the transmission on about 7010 kc/s. Quite a portion of the 7 mc band is rendered useless for many hours a day.

Japanese amateurs ran their first postwar DX contest on April 18 and 19. The contest was sponsored by the Japanese Amateur Radio League, and special QSL cards will be issued to all stations operating.

In March and April good use was made of the 160-metre band, when some excellent DX working was recorded. The first North American-Asian contact was made during the period, when ZC4CP, in Cyprus, and VE1EA, in Nova Scotia, exchanged reports. Later, W1BB contacted ZC4CP, leaving the former station only Oceania to contact to gain a WAC for 160 metres. A number of New Zealand stations have been heard by W stations on the east coast on 160, so the WAC should not be far removed.

W2PAJ, who is an expert on ionospheric matters, states that conditions on the HF bands will not improve for quite a long time. He said that at least twelve months will pass before bedrock is reached. After that period, whether propagation conditions will improve slowly or rapidly, depends on sunspot activity at the time—an unpredictable function.

Past the blueprint stage, and nearing completion, is the outstanding antenna erection of Chad, W1ATE. He should make his presence felt in DX circles with three elements on a 40-foot boom 100-feet high, on 7 mc/s, three elements on a 41-foot boom 105-feet high, on 14 mc/s, and three elements on a 28-foot boom 117-feet high, for 21 mc/s—the ultimate in arrays?

The weekend May 2 and 3 provided the 21 mc band gang with some good DX right around to ZS stations. W6AL, with three elements up 90 feet, supplied the outstanding signal.

YOUR OPPORTUNITY

› join the world-wide ranks of amateur ansmitters! The Wireless Institute of ustralia holds regular classes in Sydney › assist Sydney and suburban enthusiasts › obtain their Amateur Operators Certi- cates of Proficiency.

'rite for particulars to the Class Man- ger, W.I.A., Box 1734, G.P.O., Sydney.

STUDY THE VOICE

(Continued from Page 11)

Many stammerers are cured, but they cannot be preserved from relapses.

Mumbling is a disorder of speech rhythm also occurring early, and connected with a general state of neurosis. It responds to well directed re-education.

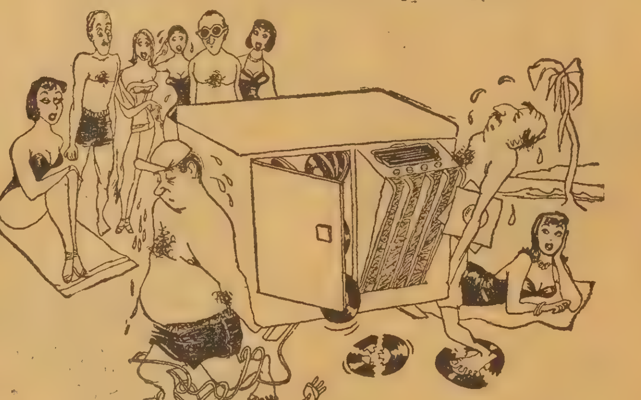
Such were the problems discussed by lecturers from many countries. They detailed the anatomy of the larynx, the psychology of the voice, experimental phonetics, language and movement, the rhythm of speech, backwardness and stammering, medical acoustics, recording techniques, voice appraisement and so on.

In his preface to the booklet which has been issued to all members of this congress, the general secretary Dr. Klotz has written: "Man acquires interest and the joy of living when silence is broken. Language expresses his being; the voice reflects his emotion; speech conveys his inner life as well as his social requirements."

To which one might add that while it may have occasioned abuse, speech still remains the most effective tool of civilisation.

(By Courtesy of the French Embassy).

Want music wherever you go?



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and take your entertainment everywhere—indoors, outdoors—all year round. Life's more fun with a portable powered with

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H.T. BATTERY VOLTAGE SELECTOR
45 60 90 VOLTS
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"Activette"
TO INCREASE THE LIFE OF DRY H.T. AND L.T. BATTERIES CONNECT THEM PERIODICALLY TO THIS UNIT FOR A SIMILAR NUMBER OF HOURS AS THE BATTERIES HAVE BEEN IN USE
BEFORE CONNECTING THIS UNIT TO THE A.C. MAINS ADJUST THE VOLTAGE SELECTOR TO THE NOMINAL H.T. BATTERY VOLTAGE AND PLUG IN THE CORRECT BATTERY ADAPTOR.
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TESTS PROVE 'Activette's' amazing ability

Tests carried out by the National Physical Laboratory of England (Report No. ETD266.51) produced the following results:

Three H.T. and L.T. batteries allowed to discharge through constant resistance and not re-activated by "Activette" lasted only 36 hours. Three other batteries of the same make and capacity discharged under exactly the same test conditions, but periodically connected to "Activette" LASTED UP TO 320 HOURS.

★ Suitable for batteries H.T. from 45 to 90 volts and L.T. 1.5 volts.

★ Simple to operate — batteries are periodically connected to "Activette" for approximately the same number of hours as they have been in use.

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The pick-up arm is moulded in plexigum, free from self-resonance. The pick-up system is a high-grade crystal with two sapphires for normal and microgroove records. Either of the two needles can be selected by means of a rocker system in front of the head. The whole head can be easily removed from the tone arm. The range of reproduction is 30 to 14,000 cycles, the needle-pressure 9 grs. The twin sapphire assembly as well as the crystal cartridge are easily replaceable.

Price of Chassis
(SYDNEY) **£19/18/6**
(Interstate) £20/10/-
Price of Chassis complete in attractive carrying case.
(SYDNEY) **£25/11/-**
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microgroove records marketed at present. The turntable is rim driven a
operates free from vibration. The automatic cut-out uses a mercury swit
which works very smoothly without danger of jerking or back-lash. Wh
the motor is switched off, the idler wheel will automatically disconnect its
so that no lasting impression will at any time remain on the idler. To repr
duce older and worn records satisfactorily the player is equipped with
three position filter. The pick-up leads are short-circuited as soon as t
pick-up reaches the running-out groove so as to avoid the disturbi
hiss between the last silent grooves and the time the motor comes to
standstill.

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HERE'S YOUR ANSWER TOM

(Continued from Page 51)

e charge and keep on attracting e speeding electrons. If they ve nowhere else to go they will entually return to the metal.

The nett effect is that a ud of electrons is present near e surface. At any given instant, ne will be going away from the ament while others will be return-g to it. The number involved de-nds on the material of which the ate is made and the temperature which it is raised. We will have ore to say about this aspect of the bject when discussing valve filaents.

In engineering circles, Tom, the fect we have just been describing known as **thermionic emission** and e cloud of electrons around the ated body is referred to as the **ace charge.**

ALVE FILAMENTS

Thermionic emission is used in the eater part of the radio valves you ill meet. Instead of a flat plate shown in the diagram the emitting ement is often in the form of a lament of fine wire or sometimes small cylinder of metal. An elec-ic current is passed through the lament causing it to get hot. The urrent has to be adjusted so that the lament is sufficiently hot to emit lenty of electrons but not so hot s to cause it to melt.

When an engineer designs a valve, e tries to make the filament emit e required number of electrons with s little energy as possible. Special oatings are used on the filaments f most valves and it is possible to ake them emit a sufficient number f electrons when raised to only a ull red heat.

One of the most important of the ther ways in which materials can be nade to emit electrons is by means f a beam of light. This is known s **photoelectric emission.**

Light is a form of energy, just as eat is a form of energy, and if a eam of light is allowed to fall on late A in the diagram, some of its nergy will go toward speeding up he electrons.

Some of the electrons will gain suf-icient energy to enable them to overcome the forces confining them to heir atoms and thus will leave the urface of the material to become **ree electrons.**

PHOTOELECTRIC TUBES

Photoelectric emission finds plenty f practical uses, too, Tom. A valve an be constructed so that it operates when exposed to light, but stops working as soon as the light is removed. Many burglar alarms and countless automatic control devices use photoelectric valves. They are also an essential part of sound motion picture machines.

The electron emitting device of a photoelectric tube is usually in the form of a curved plate, designed to make most efficient use of the available light. The material from which the plate is made has an effect on the response of the tube to different types of light, so that there are many different types of tubes for different purposes.

In dealing with the construction of radio valves, we will come up against another important type of emission, which is known as **secondary emission.**

If a free electron can be made to strike a plate at high velocity, it may dislodge several other electrons which will then move away from the plate at a lower velocity. The energy of the high velocity electron is simply divided between the electrons it dislodges.

In ordinary radio valves, secondary electrons can be somewhat of a nuisance and we have to take special precautions to remove them. However, there are special tubes nowadays which make use of them to obtain enormous amplifications.

If, whether by means of heat or light, we make plate A in the diagram emit electrons, they will ordinarily form a cloud around the plate, as we have said before. But if we close the switch, the positive terminal of the battery will be connected to plate B, giving it a positive charge.

The positive charge will attract electrons from the cloud of electrons around plate A. The circuit is therefore complete and a current of electrons will flow from plate A to plate B, from the positive terminal of battery to its negative terminal and back to plate A.

(The convention of circuit polarity was decided before electron flow was understood, hence the apparent contradiction of the electrons flowing from positive to negative.)

Now, Tom, let us see what would happen if we turn the battery around so that its positive terminal is connected to plate A, which is still emitting electrons, and its negative terminal to plate B. We have now given plate B a negative charge with respect to plate A and instead of attracting electrons, it will repel them.

In other words, when the battery is reversed, no current will flow.

This device is called a diode valve. The name springs from the fact that it has two elements, or electrodes, and that it allows current to flow in one direction only.

In practice, a wire filament is usually substituted for plate A and it can be made to emit electrons by heating it with current from a battery. Plate B is often a cylinder surrounding the filament.

PRACTICAL VALVES

The elements are sealed in an evacuated glass envelope and a base attached so that it can be plugged into the circuit conveniently.

Because the diode valve allows current to flow in one direction only, it is extremely useful for rectifying alternating currents. Large diode valves find application in rectifying the alternating current from the power mains, while small diodes are useful for rectifying radio frequency currents so that they can be passed on to the headphones or the audio amplifier of a receiver, and so on.

Well, Tom, that's given you quite a deal to think about for the time being. We will take up the story from this point next month.

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OFF THE RECORD — NEWS & REVIEWS

This month has seen further movement in the microgroove field, and from now on it can be assumed that the new records are here to stay with every prospect of steady supply and an ever-increasing variety of labels. We should see a rapid growth of stocks in both popular and classical fields.

By JOHN MOYLE

THE list of EMI releases is now reaching respectable proportions and the other companies already in the field are constantly adding new items and building up their resources.

Latest to enter the field of records generally is Philips. As I have mentioned on previous occasions, the Philips company is no stranger to recordings, its label being well known in Europe and in England. In addition to its own material, the company since November of last year has been the distributor outside America of the entire American Columbia catalogue, not to be confused with the English Columbia Graphophone Co., which operates under EMI.

FIRST ON MARKET

The American Columbias were the first microgroove records to be made public, and pioneered the 33 1-3 rpm speed for long playing records. As might be imagined, they have a most imposing array of artists and a technical standard equal to the world's best.

Some of the Philips records to be released here will be taken from the Columbia catalogue, and include many which have become household words in the USA. However, all records, no matter what their origin, will be issued here under the name of Philips.

The first batch will include 78 rpm shellac records of popular material, plus a number of 10 and 12-inch LP types to be known as "Minigroove" records. The prefix "Mini" has been a favorite of Philips ever since the early days of radio when they produced their famous line of low consumption battery radio valves known everywhere as the "Mini-watts."

However, they will conform to the standard microgroove standards and I hope Philips will pardon me if I group them at times among the microgrooves to avoid difficulties of nomenclature.

The first Philips records will be released in New South Wales and Tasmania on June 4, and in the other States one week later.

One Minigroove for which a big sale is expected is a Benny Goodman Carnegie concert recorded in 1938 and just released. It occupies two 12-inch records and special musical and historical value is attached to it.

Other classical works include the Haffner Symphony of Mozart, the Schumann Symphony No. 4, Isaac Stern's famous recording of the Brahms Violin Concerto, Don Juan and Till's Merry Pranks, by Richard Strauss, the Romeo and Juliet Overture of Tchaikowsky, and a number of others. There are no full-scale operas in the initial lists.

OTHER WORKS

When Philips really get down to work, we can expect an imposing array of recordings under their label. I have heard one or two which were made in Holland, and they were most impressive. Prices will be comparable with those already holding in Australia.

I have had the opportunity to hear quite a number of new records during the month. One of them was a complete recording of Tosca by the Vienna State Opera Company, conducted by Argeo Quadri. There are three records in an albur WAL302 released by Westminster.

There's little point in saying muc about the opera as a whole, as i is firmly entrenched in the classica operatic repertoire. It is grand, melodramatic tragedy of the first wate unrelieved by any shaft of humor—not even a faint smile.

A MORBID TALE

It's the tale of a double-dyed villian, Scarpio, in a position to wreal the most horrible deeds on a tri of citizens who have never don him any harm other than to belong t a different political party. Torture hangings, the double and triple cross, murder, suicide, and the fat worse than death all slink across th stage to vocal accompaniment. May be it's a bit childish to analyse th plot so realistically, but I'm afrai I'm not the first to imagine tha Tosca is a pretty morbid piece.

Fortunately if we can elevate ou gaze from this tale of horrible thing we will find some of the most famous music in all opera. We'll als find it very well performed, an once again bless the invention o the long-playing record in this fiel

My only criticism of the set i that the Scarpio is a trifle light fo the villain's role—I think Puccin would have done much better to mak him a bass, anyhow—and that th recording on wide range machine might show up a little fuzziness nea the end of some sides. The surfac is generally good otherwise, and th absence of undue noise show up some extremely beautiful passages.

IN BRIGHTER MOOD

Mozart's Le Nozze di Figaro is complete contrast to Tosca. Whe amorous triangles develop they ar solved by the refusal of all concerned, including the audience, t take them at all seriously. The ne result is probably no more unrea than the histrionics of Tosca, bu they set the stage for completel irresistible music. Undoubted Mozart's plots were indicative of hi age in many respects, but we aren' invited to ponder about this. Al comes right in the end, a tribute t man's ingenuity and gullibility.

All this and more is delightfull captured in EMI's Columbia releas of Figaro on three records 33 C 1007-9. The principals are Elisabet Schartzkopf as the Countess. Irmgard Seefried as Susanna, an George London as the Count. Th orchestra is the Vienna Philharmoni and the chorus the Vienna Stat Opera.

This is a really beautiful set o records, and one it will be hard t beat in its class. There is such succession of well-known and beautiful arias that one need go no deepe

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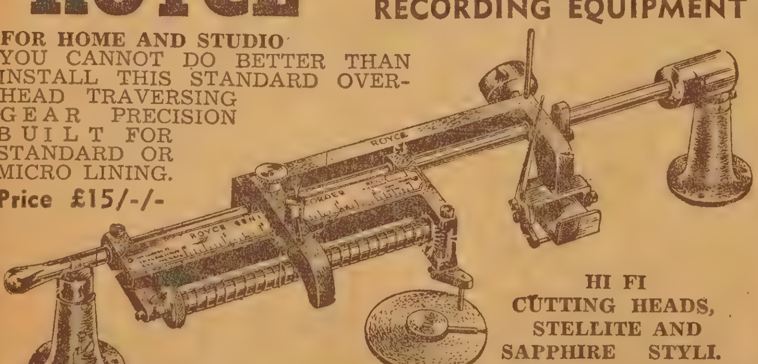

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the book to enjoy every minute .. But, in fact, it is only with a onable familiarity with the score one fully enjoys the opera.

's a bit late in the day for any- to point out the sheer genius which action, words, and music welded, and only on the stage d it be fully appreciated. But ough I'm far from being the e-reading type, this is one occa- when I can recommend it. No lanatory notes, however care- y written, could do justice to the ra, and if you feel inclined, I'd ainly advise you to hunt around a score. Choose a rainy after- n this winter, with a warm fire, no possibility of being inter- ted, and I'll guarantee the formula eptable in any language.

OOD LISTENING

'he singing and performance gen- lly is so good that it's hardly rth further mention. I might be ttle fussy and say that the Count's ce annoyed me once or twice with fruity quality, and that in a few the choruses one or two voices ich were there on the score were a hard to hear. But this is really nowledging that the completely fect recording hasn't been made d probably won't be.

Technically the records are just as od. Surface noise for the most rt is non-existent.

Summing up, I'd say that if ever u want to shatter your non-clas- al but musical friends out of their ze, play them some of this opera. one could resist it.

A few years ago, Charles Macker- s was an oboe player in the dney Symphony Orchestra, with ambition to write a ballet based the music of Gilbert and Sulli- n. Now in England, he has hieved it so successfully that Co- mbia have issued a recording of played by the Sadler's Wells Or- estra, conducted by the composer.

ULLIVAN BALLET

And what a record it is! Even ose who have grown somewhat ed of the Savoy tunes will find new interest in the bright facility ith which Mackerras has put them gether. The opera is a somewhat ntastic story of an aged sailor's ss, a crew of hearties, and a bevy females who work it all out be- een them. On the stage it would obably have quite a bit in com- on with the remarkable case of e Pirates of Penzance and go in big way. As music it is a most tenable extravaganza of Sullivan ayed with enormous zest. I think will prove a best seller, not only ith those who just like the music, it also with those with a feeling r ballet. In the first case it will t feet tapping in the approved anner, and in the second it will l the imaginative stage with chore- aphy which jumps to the mind turally and inevitably.

The recording is first class—clean d full, plenty of dynamic range, d full frequencies to an almost artling degree. The surface is vir- ally without noise—one of the ietest to date.

Another Sydney Symphony Orch- tra recording of Schwanda the agpipe Player (Weinberger) has een released on 78. This is of the me general quality as those already sale, with special mention of the 'quiet surface of the copy I heard. The playing I thought adequate and polished, but somewhat lacking in fire. A record which many will like, but not calculated to alter the general assessment of either orchestra or recordings.

I liked a Columbia recording of four overtures by Berlioz—Le Corsair, Benvenute Cellini, Les France Juges, and Beatrice and Benedict, the orchestra being the Philharmonia and the conductor Paul Kletzki.' 33CX1003.

Berlioz is something of a musical phenomenon in the history of orchestration, and all these overtures give evidence of his imagination, ingenuity, and ability to write tension and sheer excitement which has been equalled by few and surpassed by none. Without going through them individually they struck me as being quite well done and recorded although I can imagine performances with a little more of everything. But they are unmistakably Berlioz, and form quite a valuable combination particularly for students, who sooner or later find occasion to delve through his remarkable scores.

If you are a lover of Brahms' chamber music, there is a recording of the G Minor Piano Quartet played by Rudolph Serkin and members of the Busch Quartet on Columbia 33CX1012. This, I think, has already been available on 78 discs and has won much admiration for its musicianship. The LP version in no way dims that reputation—on the contrary. It is a standard work which you can buy with every confidence both in playing and recording. The performers are all specialists in this field with established reputations and a fine record of past performances.

Industry needs More engineers

US industry now requires one engineer for every 60 employees. Addressing the centenary celebration of Yale University's School of Engineering, Dr. C. G. Suits, G-E vice president and director of research, contrasted this with the year 1900, when one engineer sufficed for every 250 employees in industry.

In the GE Co. at present, he added, there is one engineer for every 20 employees.

Dr. Suits foresees no apparent saturation point for scientific and engineering manpower in industry. The need for trained people for the development of industrial technology will continue long into the future, he added.

Citing the need not only for more engineers, but also for engineers who can keep abreast of the rapid advances in their fields, Dr. Suits pointed out that they can no longer acquire, during formal college training, the store of technical information that will form the tools for the rest of their careers.

"The engineer who stays in practice finds more difficult than ever before to remain current in his technical knowledge.

"We must recognise the need of replenishing and renewing knowledge as a consequence of rapid technological progress," he continued. "Perhaps college refresher courses in latest engineering developments would make it possible for the practising engineer to augment his fund of specialised knowledge.

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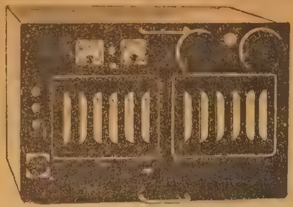

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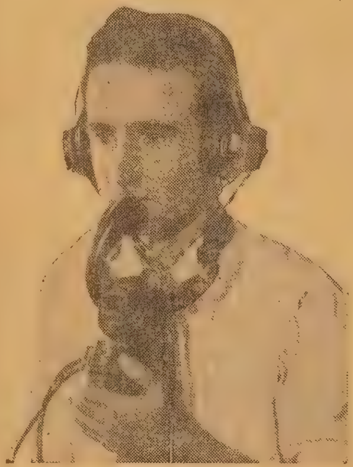

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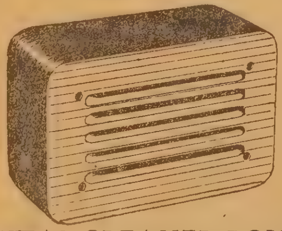

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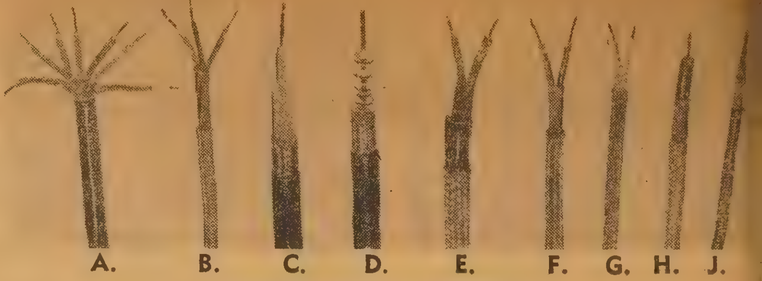

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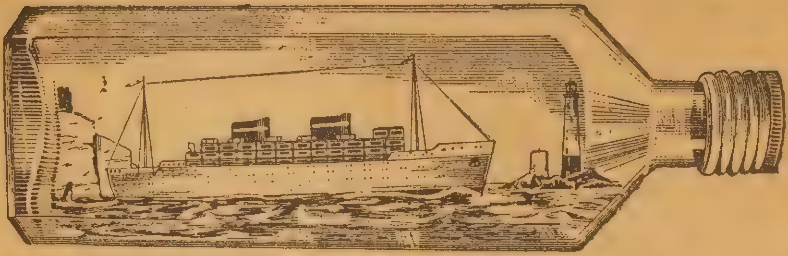
BUILDING A SHIP IN A BOTTLE

ilding a ship in a bottle is not arly so difficult as is generally agined and any amateur aftsman should be able to oduce an effective model from mple materials in a few hours. is article describes a simple esign, while more ambitious nes may be tackled as skill is acquired.



MODEL of a ship in a bottle often puzzles, yet always appeals veryone. It takes very little time ake, costs but a few pence, yet if e for sale will sell readily at a price.

ne materials required are as ows: Several lengths of stout , some odd scraps of wood, putty, k-drying enamel or paint, and ottle either of the round or are variety. If possible, a square le should be used, owing to the ter neck.

he parts are passed into the le by means of a length of wire n a needle firmly attached to it. ther length of wire with a ½in. end bent is used to form the rake ch pulls the parts into position en they are in the bottle. At least lengths are required for the shes; tufts from an old clothes-sh answer very well, being secur- firmly with thread.

AIN PARTS

he ship consists of the following ts: the hull, the body, the top, and sts.

he length of the hull is 5¾in. by ½in. square. The raised fo'c'sle and stern are shaped from the solid hull. A glance at Fig. 1 should make its construction quite clear. Holes are drilled through for the rigging, and two holes are bored from the top to the bottom so that the foot of the mast can be secured with wire.

A hole is also bored at the bows to take the mast stay. Two masts are now required, each being 1¾in. by 1-8in. diameter. Two holes are then bored in each, the upper being for the rigging and the lower for securing them to the hull.

HINGED MASTS

Secure the masts to the hull with wire as shown in Fig. 2, and pass a length of cotton through the left-hand hole of the hull through the mast from the back to the front, down through the right-hand hole in the hull, up again, through the back to the front of the mast, down to the starting place and draw taut and knot.

Having wired on and rigged the masts, the next step is to put on the mast stay, which consists of thread or silk cotton. This is done as shown in Fig. 1 and the masts can now be raised or lowered, the rigging remaining taut.

Care must be taken that the mast stay is sufficiently long enough to grip on the outside of the bottle. If the mast does not lie flat a piece can be cut from the hull, which can afterwards be covered by a thin piece of wood.

The body is made from three strips of wood 3in. by 5-16in. by 3-16in. and four strips of very thin cardboard 3in. by ½in.; these are glued together with the cardboard at the top and bottom and the remaining pieces of cardboard dividing the wood as shown (Fig. 3). (The edges of the cardboard overlapping the piece of wood may be sewn if desired, though it is not essential.)

If sewn the cotton becomes stiff after painting and appears like rails. Dots may be added to give the effect of the portholes.

SUPERSTRUCTURE

The top is made from a strip of cardboard the same size as the body, and to this is fitted the bridge, boats, ventilators and funnels. These are all glued on to the top, excepting the funnels, which are placed separately in position in the bottle.

Matchsticks are suitable for the boats, while pieces of dowel rod will do for the funnels, the length of which are ¼in.

Small hatches, &c., may be added if desired.

Obtain a square bottle if possible, thoroughly clean and dry, and paint the bottom and end blue. The land is painted green, great care being taken that the brush does not touch the front of the bottle nor the front half of the top, as the whole view is obtained here, the remainder being the background. Unless the bottle is painted the putty will show white underneath when the bottle is turned over.

When dry, the putty should be put in piece by piece and spread over the bottom with the rake, spreading out very thinly and making a sloping design to represent the land. As soon as the putty is in, paint the sea blue; a few dabs of white added give a good effect. The land can then be painted green.

After painting, a few red-top houses about a ¼in. square may be added, as these show up well and look quite large from outside the bottle. As each part of the ship is

(Continued on Page 101)

Fig. 1

Fig. 2

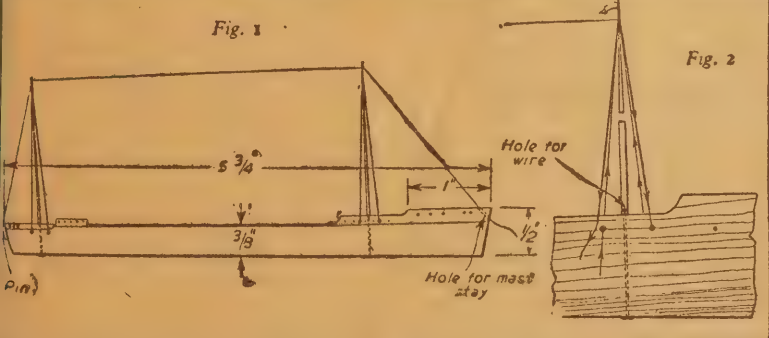


Fig. 1 (left) shows the general layout of the masts and rigging. The mast stay which uns through a hole in the bow is used to erect the masts and rigging after the hull s placed in the bottle. Fig. 2 shows details of the forward mast and how it is hinged at the base.

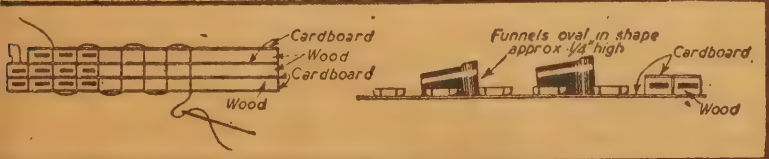


Fig. 3 (left) shows how the body of the ship is formed from alternate layers of lywood and cardboard. Thread is used to simulate railings. Fig. 4 (right) gives details of the bridge, funnels and boats. The funnels are fitted after the remainder is assembled in the bottle.

ANSWERS TO CORRESPONDENTS

M.R. (Cairns, Nth Qld.) queries a reference given in the "Teach Yourself Radio" (8) on page 79 of the April, 1953, issue of Radio and Hobbies.

A. We think you'll find that the Little General for 1952 does appear in the September, 1952, issue. Its description commences on page 28 of that issue. Incidentally, in the underchassis wiring diagram, the .1 megohm resistor to earth from pin 6 of the 6BV7 should be 1 megohm. In the parts list the "1 1 meg. ½w," should read "1 .1 meg. ½w". We are pleased to note your enthusiasm for the series of articles for beginners.

P.J.K. (Franklin Mine, Michigan, USA) writes to thank us for publishing his recent request for pen friends interested in radio and allied subjects.

A. Very glad to hear that the response has been so good P.J.K., and we hope that you will have more replies to your request. Many thanks for your good wishes and kind remarks about the magazine which we hope will continue to provide you with such interesting reading. If you evolve any circuits which you consider sufficiently unique, we will certainly be glad to receive them for possible publication in the "Reader Built It" column.

N.G. (Singleton, NSW) requests the plan of a radio to fit in the mast of a sailing boat.

A. We regret that we cannot undertake the design of a special radio set to suit the requirements of one particular reader. However, it is possible that the "Carry Set" which was described in Radio and Hobbies for October, 1949, would suit your purpose. We can supply the circuit and other relevant details through the 2/- query service.

R.M. (Marrickville, NSW) writes to tell us how he went about repairing a radio which was distorting.

A. Thanks for your letter R.M. We will pass it on to the Serviceman as he may find it of interest.

D.O.S. (Coolangatta, Qld.) writes to ask our opinion of a commercial receiver chassis which was advertised in Radio and Hobbies and which was subsequently treated in the trade review section.

A. There is nothing we can say about the receiver that we have not already said. It appears to be well constructed and gives an excellent performance.

L.D. (Eildon, Vic.) asks if we can supply a circuit diagram of a detector for gold prospecting.

A. We assume that you refer to some type of metal detector. Although these have been referred to in Radio and Hobbies at various times, we have never actually described an instrument intended for duplication by our readers. Therefore we cannot help you with a suitable circuit.

C.B. (Avoca via Moss Vale, NSW) writes to say he recently built a 1 valve receiver which is performing excellently. He finds that faint signals are still audible when one of the headphone wires is disconnected.

A. You do not give us any details of the circut so that it would be difficult to pinpoint the exact reason. However, when the lead is disconnected there is probably some return path, either through a high resistance representing the leakage in the insulation or a small capacitance due to the proximity of the wires. In any case, it is not likely that there is anything wrong. Simply connect the phones as specified by the circuit and use the set normally.

R.B. (Dorrigo. NSW) forwards a problem to the Serviceman Who Tells concerning interference from a 240 AC power plant.

A. Although the Serviceman frequently requests readers to forward details of interesting case histories he regrets that he cannot, in any circumstances, conduct a postal query service and he has, therefore, handed the letter back to us for our comments. It would seem that you have tried most of the usual tricks for problems of this kind and the fact it still persists makes it rather difficult for us to suggest a cure. It would seem that the best approach would be to determine, if at all possible, the actual source of the noise, which could be due to a number of things. These include: The brushes on the DC exciter; the brushes on the alternator, particularly if there should be a defect on the surface of one; the ignition system on the petrol engine; any contact systems which might form part of the voltage regulating system. By noting the frequency of the interference relative to the operating speed of the various moving parts it may be possible to determine which is the offender and to treat it accordingly. generally by by-passing. In any case it seems fairly evident that the power lines are radiating the interference and that it may be necessary to install additional filtering at the outlet from the generat
Very effective filtering is provided
means of a line filter (Radio and Hobbi
January, 1953), but it must be appreciat
that, if used at the outlet from t
alternator, it would have to carry t
total current of the entire electri
system. For this reason the RF chok
would have to be wound with hea
gauge wire, probably in the order of
gauge.

H.T. (Singapore, British Malaya) mak
some enquiries about crystal micropho
and in particular about the problem
storing these devices in the tropics.

A. We regret the complete descripti
of the construction of a crystal micr
phone is beyond the scope of this se
vice, but it is usual to anchor the cryst
to the case by three corners and
the diaphragm by the remaining corn
in the sound cell variety there is
diaphragm and the crystal is operat
by the sound waves striking its surfa
Local agents for these devices advi
that it is quite common practice to sto
them in silicagel in tropical climat
and that this method is normally qui
satisfactory. However, they warn pa
ticularly against submitting them to hi
temperatures and point out that a te
perature in excess of 120 degrees F w
definitely ruin the crystal by causi
it to dissolve in its own water
crystalisation. They also point out th
it is quite easy to achieve this temper
ture even in temperate climates if t
device is exposed to direct sunlight.

R.B. (Boree Creek, NSW) had the mi
fortune to burn out the switch wafers
his multimeter and is now puzzled
to how the new wafers should be fitte
the manufacturers having supplied
combination of shorting and non-shorti
wafers.

A. The switch manufacturers are qui
correct R.B. and the ideal switch
one which uses a combination of shor
ing and non-shorting wafers. Howeve
such a switch was not a standard ite
when we described the multimeter a
we were forced to use one having
shorting type wafers. The most i
portant point is to use a shorting ty
wafer for the shunt (m/A) ranges
order to ensure that the meter is n
overloaded as the switch is moved fro
one range to another. Ideally a no
shorting wafer should be used for t
multiplier (volts) ranges and, in the ca
of the multimeter described in t
"Learn While You Build it" series, a
for the resistance ranges. These are n
nearly so critical as the shunt ranges a
the main thing is to ensure that t
range is given a shorting type wafer.

L.D. (Ryde, NSW) would like inform
tion on a short-wave receiver using
IT4 and a 3S4. He also wonders if
speaker he has on hand would be ab
to be used with the set.

A. A circuit which may interest y
was published in the February, 19
issue of Radio and Hobbies. It us
two IT4's and a 3S4 but the 2nd I
could be omitted if you so desire wi
some loss in gain. A simpler version
the set which did not employ a 2nd I
and with no short-wave coil was describ
in the January, 1953 issue and this m
serve as a guide. If you write soon,
will be able to post you both issu
for a total cost of 3/6. Otherwise
can supply the circuits and wiring di
grams through the 2/- query service.

A.H. (Dimbulah, Q.) forwards a lett
to the serviceman detailing some of h
customer problems, as well as an i
teresting problem on the elimination
interference from a generating plant.

A. Thanks for your interesting lett
A.H., which we have passed on to t
serviceman for his possible comment
a later date. In the meantime we c
only agree that many customers ne
to be handled with considerable ta
Your interference problem is an i
teresting one, thought it is rather dif
cult to give an exact explanation witho
being able to examine the actual layou
However, the important point is th
you have cured the trouble and poin
out the wisdom of pursuing these pro
lems even though they appear incapab
of solution at first.

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AMJETS PROVE THEIR METAL

(Continued from Page 5)

t the ramjet engine noise from ping.

ombustion research and develop- it is generally initiated with vy-duty engines of "battleship" struction, and these engines, inted on a test carriage, may gh several tons.

upported at eight points on pistons ting freely on a film of oil under h pressure, the apparatus can be ved with the touch of a finger.

he heavy stand with its ramjet be moved several inches for ad- tment. Pressure-sealed slip joints the air intake and exhaust pipes the ramjet enable the engine to h against sensitive, thrust- asuring devices which were ecially designed to measure the formance of ramjets.

nclosed on three sides by re- orced concrete walls 18in thick l on top by a concrete ceiling 24in ck, the engine is observed through uble panes of high-strength glass engineers in an adjacent control om.

At the opposite end of the control om an operator controls the com- essors and the heaters supplying e "bird" on test.

As different fuel mixtures are fed to the ramjet and its power output ounts, research assistants take ries of simultaneous readings from e banks of instruments in the con- ol room. For greater detail, photo- aphs are taken at the same time of e dials and tubes.

Outside the cells, another evidence the flexibility of the jet-burner boratory is the way in which the haust system is mounted on rollers d rails. Heat expansion makes the haust tubes and silencers roll ightly on their rails.

BUILDING A SHIP IN A BOTTLE

(Continued from Page 99)

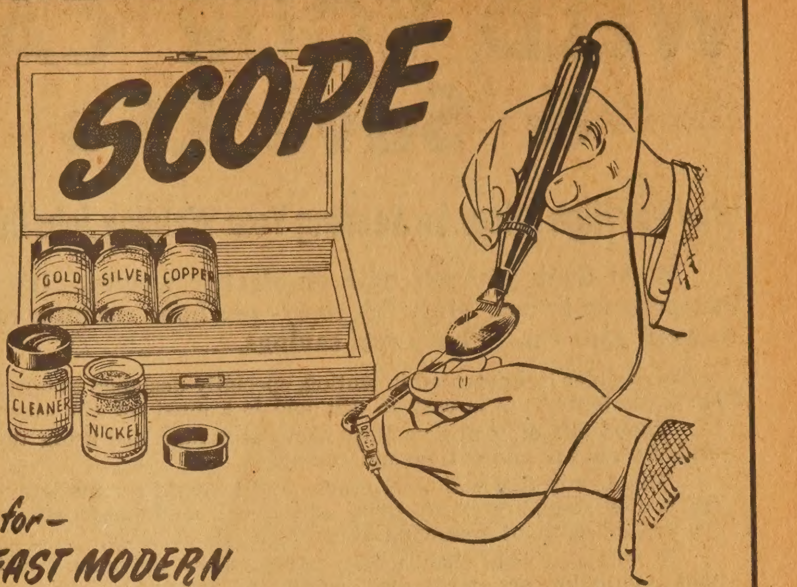
nished it should be painted, as it is npossible to paint the ship once it is nside the bottle.

The hull of the ship should be ainted black except 1-8in. from the ottom, which should be painted red. he body, edges of pieces, and top re painted white, and the funnels re red, with black tops.

With the ship and the bottle ready is quite easy to get the ship fitted p inside. Lay the masts down to- vard the stern and push the hull into ne bottle stern first. As soon as the ow is clear of the neck, hold it own with the rake and pull gently n the mast stay. As soon as the nasts are upright, push the hull fur- her in, and then press down firmly vith the rake.

A spot of glue placed on the end f a wire, dropped into the hole at he bows, will secure the mast stay. llow a few minutes to dry, and hen cut off as close as possible to he end of stay, twirling the remain- ler round with a wire and burying t out of sight on the land side of hip.

The next piece to be passed in is he body, which is glued in place. he same operation applies to the op, funnels, and bridge piece.



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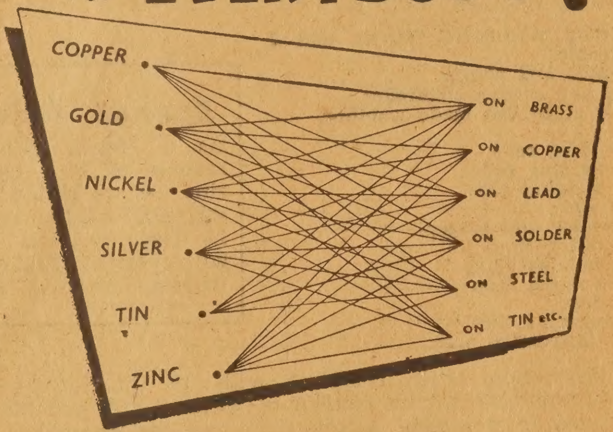

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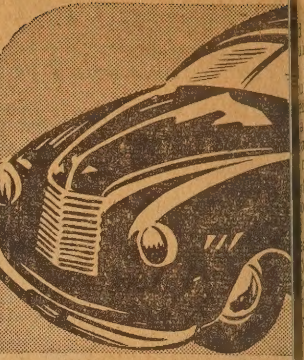

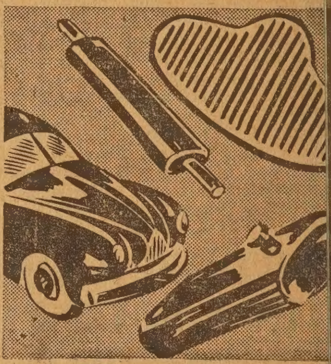

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LET'S BUY AN ARGUMENT

(Continued from Page 43)

id the 5 bc mark and the cone ure behaves like a lot of inter- springs, it is inevitable that output valve should see the er primarily as an inductor a lot of other little inductors capacitors across it, plus only resistance.

ybe that is putting it crudely, ou can see what I mean. It d be interesting to make a study eaker impedance curves with a ty of diaphragms and loading ods.

wever, I guess that's enough just on that particular subject.

* * *

u may remember that we pub- d a letter from "J.R."* in the issue, in which he condemned ent ideas on aerial propagation suggested a theory of "magnetic les."

made no comment, but merely ed other readers to answer as saw fit. One letter is published page 41, the other follows here. writers seem to agree with the pised" textbooks and, on this sion, I can't blame them for so g.

ear J.R.,

e trouble with the average book radio theory is that the author o apt to use analogies and only frequently pushes them further is warrantable. This, com- d with the necessarily brief tment, within the one set of rs, of the various branches of the can be very misleading to the rage student.

efore we go any further, let me that your theory on radiation is ng.

et us take one standard antenna a ½-wave dipole in free space. s it have a ground wave? If will your sky wave now be pul- ng DC? Starts to get awkward n here on doesn't it?

ou sound rather confused, too en you state that frequency de- nines wavelength. It's just two ys of saying the same thing. If io waves travel at a constant ed (strictly speaking they don't), n you can either say that so ny waves crests are passing your nt of observation per second or e you can say that the distance ween successive crests is so many tres.

The alternations in your antenna not determined by the rotation your magnetic bubble. Go back your simple AC theory, J.R. The e and fall of the alternating volt- e sets up a magnetic field which lows the rise and fall of the volt- e. Note particularly here that the ld follows the voltage. It does appear instantaneously but does e a slight lag.

The AC (in our case of radio fre- ency) is applied to the antenna in appropriate manner and creates electric field around the antenna ich in turn creates a magnetic ld. As long as the AC keeps ris- , both these fields will expand when the AC starts off back in reverse direction the fields start collapse at the same rate. By the e the AC has again become posi- e and rising, the end of the first ld finds another field of opposite n between it and its point of gin.

Being thus cut off from its base it promptly collapses (having nothing now to maintain itself with) and in so doing creates an electric field of its own. This situation now reverses and the electric field in collapsing creates another magnetic field, and so on, until the energy is dissipated in space. This is your radiation.

The best way to imagine your antenna is to stand a pencil on a mirror.

This will be approximately ¼-wave (actual conditions and requirements will make it vary from this). Now any blob of R.F. applied to the base of the pencil will see ¼-wave up above and another down below reflected in the mirror and will hastily assume the whole thing to be ½-wave and go to work accordingly.

The theory of radiation is difficult to explain simply in a letter but you now have the main mechanics of it. Don't forget, though, that polar diagrams are drawn to represent conditions existing at one particular moment of time when seen from one particular point in space.

What you see from point A is not necessarily what you see from point B. For instance, broadside to a ½-wave dipole you see a figure 8 pattern; the end-on view will be a circle.

I hope this has cleared some of the misconceptions you have managed to pick on this not at all easy subject. Your remarks and ideas of TV will have to await their revision for another letter. This one is getting too long already.—Yours sincerely, GEOFF. C. HALL.

Power from lava

A JAPANESE electricity company has applied for government permission to generate electric power from the hot volcanic lava beneath Japan's thin earth crust.

Kyushu Electric Power Company expects to produce power within two years from its plant on Kyushu, Japan's southern island.

THE CHEMISTRY OF GERMANIUM

(Continued from Page 9.)

contact with the germanium wafer, instead of one wire.

More recently, they have consisted of a single tiny block of germanium, which has been so treated that the centre section has properties that are different from those of the two end sections. The earlier type is called a point-contact transistor, while the newer type is called a junction (or area) transistor.

In communication equipment, in computers, and in many other types of electronic equipment, the small size and greater dependability of the transistors should permit major improvements in design and importance. Transistors are now in the pilot-plant stage of production.

The photoelectric effect of germanium diodes tends to produce equipment which has advantages over the present "electric eyes."

Germanium rectifiers that will operate in the ranges of selenium and copper-oxide rectifiers are in the development stage. Some magnesium germanate is used as a phosphor in fluorescent lamps. Germanium is transparent in infra-red light; hence, it may be used in special optical units. Gold-germanium alloys have been suggested for use in dental work or precision casting, because of their expansion on solidification. The low-melting gold-germanium eutectic could be used as an improved gold solder, or in the reduction of the melting temperature of gold-containing alloys.

USE a well-fitting knob screwdriver when securing knobs on to control shafts to avoid damaging the grub screw slot. It lends for easier removal.

BE very careful when servicing a receiver operating from DC mains. The earth bus can be "hot" with respect to the chassis or an earth lead by the full mains voltage.

More about 1953 "Little Jim"

(Continued from Page 39)

coverage conveniently from 25 to 2.3 Mc. This takes in most of the interesting amateur and international short-wave bands.

You can vary the wire gauges slightly either way without too much effect either on performance or coverage.

Both reaction and aerial coupling are fairly critical on short-waves.

Too much aerial coupling, while not affecting selectivity as obviously as on the broadcast band, does affect the operation of the detector circuit. There is a tendency for the aerial to cause "dead spots" in the bands where the detector is most unwilling to oscillate.

Don't make the mistake of piling on more and more reaction turns in the hope of correcting the situation, because the set will become unmanageable elsewhere in the band. Generally, the cure is to reduce the aerial coupling, either by reducing the number of turns or sliding the two windings further apart. You may still notice a region where the reaction condenser has to be pushed in more than you would expect but it should be possible to avoid completely dead spots.

Incidentally, you can save yourself a few shillings by winding the short-wave coils on discarded 6-pin valve bases, the larger ones being near enough to the requisite diameter.

By winding a 4-turn coil on a smaller diameter valve base, you could probably tune to the 10-metre amateur band, although activity in this band is rather restricted at the moment.

Similarly, by winding a coil midway in specifications between the broadcast and the first short-wave coil, you could cover the slight gap around 2.1 Mc. It is very doubtful whether this would be worthwhile, however, as the region is rather freely "populated" with harmonics of the broadcast-band transmitters.

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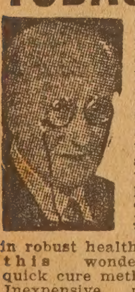

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